PANEL-DATA ANALYSIS OF PREFERENCE CHANGES IN MEAT DEMAND--APPLICATIONS OF EXTENDED CENSORED REGRESSION MODELS

BY

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A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN A PARTIAL FULLFILLMENT
OF THE REQUIREMENTS OF THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1995

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ACKNOWLEDGEMENTS

I would like to express my deep appreciation and gratitude to Dr. Ronald Ward, the chairman of my supervisory committee, for his competent guidance and patience in the preparation of this dissertation. His insightful advices have been instrumental in bringing this dissertation to a successful conclusion. I would also like to thank the other members of my committee, Drs. Kenneth Tefertiller, Chris Andrew, and Steven Shugan for their constructive criticisms and comments. Special thank goes to Dr. James Simpson for serving on my final exam on a short notice.

My graduate study has been valuable experiences due to other faculty, staff, and fellow students in the Food and Resource Economics Department. I would like to recognize them all.

Heartfelt appreciation goes to my uncle, Dr. Chungho Lee and his family in Pensacola, FL. Their continuous encouragements over the years have been of great spiritual help to me and my family.

I am most grateful for the companionship and patience of my wife Sunyoung during the research period. Without her understanding and support, I would not have been able to complete the doctoral programs. Having our first daughter, Hannjoo, was one of the most grateful moments in our days in Gainesville.

Finally, I dedicate this dissertation to my parents in appreciation for their unconditional love, and appreciation for education.

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December, 1995

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Dramatic changes in meat consumption patterns over the last two decades have led researchers to test for structural change in the utility function for meat. Most studies detected structural changes in preferences for beef and chicken. Health concerns, increased demand for convenience, and changes in demographics have been suggested as potential causes of the structural changes. The objective of this study is to measure, using NPD(National Panel Diary) data, the impacts of those variables on the consumption of beef, pork, chicken, turkey, and fish.

NPD Group provides attitudinal variables on various aspects of meat attributes, thereby allowing researchers to explore potential preference changes in meat consumption. Since NPD data do not include price information, quarterly prices from USDA and information on beef checkoff programs were brought into the NPD database. The NPD database includes households reporting the number of servings of various meat categories in a two week period. This study uses the number of household servings divided by household size as dependent variables.

The per capita servings include a significant portion of zero reports in each meat category. To deal with the zero observations, various censored regression models were examined and double-hurdle models were chosen to fit the NPD frequency data. Double-hurdle models distinguish market participation from the intensity of consumption. If all of the zero observations are believed to be desires not to become consumers rather than continuous optimal consumption level, the first-hurdle dominance model, a special case of the double-hurdle models, is appropriate.

Empirical results from the first-hurdle dominance model show that both the participation and intensity of the consumption for beef are significantly affected by health concerns, market size, education of female head, dummy for middle-income group($20,000-$49,999), employment status of female head, beef price, and beef checkoff expenditures. Health concerns had statistically significant negative impacts on pork consumption and positive impacts on the chicken, turkey, and fish models. While they were not statistically significant in both stages of the chicken model, participation decisions in the turkey and fish models were significantly influenced by health concerns.

Beef checkoff programs were shown to have significant and positive impact on both the participation and intensity of the beef servings. Simulation techniques were used to illustrate the changes in the probability of being consumers and in the per capita servings. The impact of beef checkoff expenditures on beef prices were indirectly derived using estimated parameters of the beef model.

Overall, the NPD data produced results quite consistent with expectations and previous studies. The consistency suggests that the NPD data could be a companion source of data for meat demand analyses.

CHAPTER 1
INTRODUCTION AND PROBLEM STATEMENT

Economics of Consumer Behavior and Preference Change

Neoclassical analysis of consumer behavior is based on the assumption that individual consumers(households) allocate expenditures on commodities as if he had a fixed set of preferences described by an indifference map or by an ordinal utility function. The theory also presumes that consumer behavior is motivated by utility maximization. Once the shape of the indifference map or the form of utility function is determined by the fixed set of preferences, then consumer optimizing behavior depends only on relative prices and income. Preferences do not play any further role in the neoclassical framework of consumer theory. The idea behind this neoclassical framework is that preferences remain quite consistent over time and changes in the preferences are negligible in determining consumer behavior. To the neoclassical economists, pursuing a greater role for preferences in consumer theory fell into the domain of psychology(Friedman, 1962). As a consequence, most of modern empirical demand studies have emphasized the variations in prices and income to explain aggregate(market) consumption behavior over time.[1]

However, in modern economies, consumers preferences tend to be influenced more or less systematically by advertising and other forms of information about products characteristics or attributes, and by changes in social and technological factors exogenous with respect to the consumer economy. Moreover, consumers encounter new and differentiated products on a daily basis. Thus, it is hardly conceivable that the form of utility function of an individual remain unchanged. Aiming at the unrealistic aspects of the assumption of fixed preferences, Bassman(1954) developed a theory of consumer demand with variable preferences, in which an individual's preference is represented by the utility function

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[1] Using aggregate data has been justified on the ground that economics is uaually more interested in market behavior rather than individual behavior, even though cross sectional differences in tastes tend to be ignored.

$$(1-1) \qquad u_t(x_t;\ \theta)$$

where X_t is a vector denoting the quantities of distinct goods and services and θ is the parameter vector which describes the form of the ordinal utility function. To incorporate variable preferences, Bassman assumes that θ_i depends on the variables a_j, where a_j denotes, for example, the money expenditure by the seller of x_j in advertising that commodity to the consumers. Then, it becomes

$$(1-2) \qquad \theta_j = \theta_j(a_1,\ldots,a_n/x) \qquad or \qquad \theta_j = \theta_j(a/x)$$

where a is a vector. Combining the two equations, we get

$$(1-3) \qquad u[x_1,\ldots,x_n;\ \theta_1(a_1,\ldots,a_n),\ldots\theta_n(a_1,\ldots,a_n)] \qquad or \qquad u[x;\ \theta(a)]$$

Recently Capps(1991), in order to formally introduce health and nutrition factors in food demand analysis, redefined a_j as types of state variables such as stock of knowledge or psychological stock of habits. Then, the state variables may consist of scientific information pertaining to cholesterol, sodium, dietary fiber or saturated fats for the food demand analysis. Maximization of equation (1-3) with respect to x_j, given a_j, under neoclassical conditions, yields Marshallian demand functions of the form

$$(1\text{-}4) \qquad q_t = q_t[y_t, p_t; \theta(a_t)]$$

The resulting demand equations indicate that consumer demand relationship depend not only on prices and income but also a vector of state variables. However, Capps acknowledges that while theoretically attractive, typically the lack of reliable health information or awareness indicators, over a period of time sufficient for demand analysis, severely hampers the implementation of this approach. This is because it is hard to quantify information on health and nutrition or any factors other than prices and income objectively. Exceptional efforts in this area have been made by Brown and Schrader(1990) and Ward(1993). An index of cholesterol information based on medical journals dealing with the linkage between cholesterol intake and heart disease was derived by Brown and Schrader, which was applied to shell egg demand analysis by Brown and Schrader(1990) and to a beef demand model by Capps(1991). Recently, Ward(1993) has developed an index of consumers concern for fats, cholesterol and preservatives from a NPD survey data over the period of 1984-1993.

An alternative way of looking at the variations in preferences or incorporating variables other than prices and income in food demand analysis, is using cross-sectional survey data which are available from several public and commercial institutions nowadays.[2] Basically, cross-section data are viewed as reflecting longer run behavior caused by changing preferences and demographics, while time series data reflect shorter run behavior given that preference and demographics are constant. In fact, time-series demand analysis, besides faced with the difficulty of obtaining or quantifying non-economic factors, frequently ignores demographic factors such as family size and composition, race, education, occupation and other socioeconomic characteristics. Analyses using cross-sectional surveys of household food expenditures can address these potentially important dimensions of observed consumption behavior. One of the other advantages of using the survey data comes from the idea that changes in preferences can be best captured from individual consumers rather than aggregate time-series data(Capps, 1991).

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[2] Major public sources of the cross-section data include USDA(Household Food Consumption Surveys) and HHS(National Health and Nutrition Examination). For more complete description of cross-section data, see Schrimper(1987).

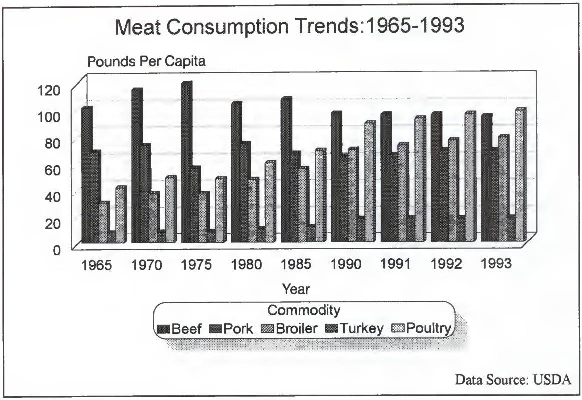
Demographic variables have played an important role in providing some of the information economic variables could not provide. They, however, still have little to do with preference analysis which is mostly composed of unobservable psychological variables. Fortunately, more recent cross-sectional surveys contain attitudinal responses of consumers about product attributes or various aspects of consuming the product as well as demographic and socioeconomic characteristics. Attitudinal responses refer to the consumers internal or psychological information processing results. Hence, the attitudinal responses can provide the most immediate information to the exploration of preference structures. When the data set is longitudinal, it can be a source of ample information about consumer food purchasing behavior. To use the attitudinal data, conceptual background is needed to link the attitudes toward attributes of food to consumption behavior. This conceptual base must draw on economics, sociology and psychology(Buse and Haidacher, 1987).

Marketing makes use of concepts of sociology, psychology, and economics to develop an integrated view of consumer behavior. Study of consumer behavior is an essential part of marketing because firms need to identify what consumers want. They need to know how consumers think and act; thus the use of psychology enters the model. Consuming a good or service is a social behavior, hence entering sociology. Because consumer behavior is one aspect of human behavior, it is only natural that the behavioral sciences have made a contribution. According to this integrated view, economics only partially explains consumer behavior. This conceptualization of consumer behavior deals directly with changes in preferences as one of the main elements affecting consumers food purchasing behavior.

Preferences are defined as sets of attitudes in psychology(Redman, 1979). An attitude is again defined as a relatively enduring organization of beliefs around an object or situation predisposing one to respond in some preferential manner(Rokeach, 1968). Attitude plays a key role in consumer behavior because attitudes represent our summary evaluations of various elements in the world around us(Wilkie, 1986). That is, attitudes offer efficiency to us. There is no need to go back to our long-term memory, recall everything we know about an object, and then decide how we feel about it. Simply, we are able to refer to our attitude to recall our general evaluation. Most researchers agree that the attitudes are learned, which is consistent with the concept of variable preferences and with the characteristics of modern economy in which advertising and information play a tremendous role(Redman, 1979). Thus, by introducing new concepts from other disciplines and with the recent attitudinal survey data, ways exist for analyzing preferences rather than assuming that they are constant or irrelevant in economic analysis.

Meat Consumption Trend and Structural Changes

Meat provides an example where changing preferences likely have been an extremely important element explaining consumer behavior. Over the last two decades, there have been substantial shifts in consumption from red to white meat. From 1970 to 1993, beef consumption declined by 19.2 percent, while chicken and turkey consumption dramatically increased by 105.9 and 122.2 percent, respectively(USDA, 1993).[3] Figure 1.1 clearly shows the substantial changes in meat consumption trend over the period of 1965-1993.



Data Source: USDA

Figure 1.1 Per Capita Meat Consumption Trend: 1965-1993

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[3] Red meat per capita consumption is based on carcass weight, while poultry consumption is based on ready-to-cook weight.

During the same period, the purchasing power of the consumers has risen gradually. Given the positive income elasticity found in the literature, hence, the rising income can not be an explanation of the decline in beef consumption. Real beef prices in general increased in the mid-1970s, but decreased in the 1980s. A sharp decrease in the real price of beef during the 1980s does not appear to be consistent with the quasi-stagnant per capita beef consumption during the same period. The beef price from the late 1980s to 1993 has been rising again steadily. Thus, while own price can still be a legitimate source of the decline of the beef consumption in the early 1990s, it does not explain the trends of beef consumption over the last two decades in a consistent way. Finally, the effects of other substitutes must be included in explaining consumer behavior. From 1970 to 1985, the real price of beef and veal has decreased by 13.7 percent, while real pork prices decreased by 18.36 percent and poultry price by 24.65 percent(USDA, 1985). This suggests that price-induced substitutions from beef to pork and poultry could be a possible explanation of recent shifts in meat consumption patterns. In more recent years this is probably less true, however.

Confused by the seemingly inconsistent meat consumption pattern with neoclassical theory, several studies(Brascher, 1983; Chavas, 1983; Dahlgran, 1988; Thurman, 1987; Moshin and Meike, 1984; Eales and Unnevehr, 1993)have conducted econometric tests to see if there have been significant structural changes in the underlying meat preferences. Structural change is defined as a change in some basic hypotheses used in the analysis of economic behavior(Chavas, 1987). Narrowing it down to consumer behavior, structural change is equivalent to a preference shift represented by modification in the utility function of a household. The underlying utility function for meat was not constant over the data period.[4] Meat demand analysts are being compelled to look beyond the neoclassical framework and to use demand models that internalize variable preferences. Cross-sectional analysis using attitudinal survey data can contribute to the explanation of meat demand.

This research is motivated by the apparent inability of the traditional variables to explain and to predict the observed changes in meat consumption patterns over the last two decades. Accordingly alternative and interdisciplinary models that complement traditional demand models will be developed.

Problem Statement

Given the theoretical and empirical issues about the qualification of the traditional variables to explain the whole story of the changes in meat consumption patterns over the last two decades, meat demand analysts made serious attempts to statistically test the hypotheses that there have been significant changes in the underlying utility function for meat. Most tests were for parameter instability in traditional demand equations. Confirmed parameter changes imply underlying preference changes for meat. The varying parameters do not reflect true average consumer responses to economic variables over the given period of time. Except for the studies of Chalfant and Alston(1989) and Moshini and Meike(1984), most of the researches on this issue detected structural changes somewhere in the 1970s, although the possibility of the detection coming from a model misspecification cannot be ruled out.

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[4] Other papers argue that relative prices and income alone can rationalize the observed changes. Details on this matter will follow in the next section.

An obvious question is what caused the shifts in the consumer preferences for meat. Identification of the causes of the shifts in preferences is extremely important to the meat industry and to overall societal welfare. The meat industry needs reliable informations for appropriate marketing strategies including advertising and for long-term production and investment decisions. Also, society can benefit from the correct allocation decisions of scarce resources based on the reliable prediction of future demand structures.

Acknowledging the contribution of the changed relative prices between beef and poultry to the shifts in meat consumption patterns observed over the last two decades is not negligiable, some of the above mentioned studies hypothesized that increased health and nutrition awareness, especially on fats and cholesterol, was a major factor pushing structural changes(Chavas, 1983; Moschini and Meike, 1989). Consumers have long associated red meats with high saturated fats and cholesterol. News medias, journals and attitudinal surveys show the rising concern about nutritional content of meat(Borra, 1988; Jones and Weimer, 1980). There has been an increased number of medical research results about the linkage between diet and health, especially between fat and cholesterol intake and heart disease, over the last two decades. Thus, it is quite imaginable, even without the formal evidence of structural changes in utility function, that consumers might have assimilated the new information and rationally adjusted their attitudes toward consuming meat and thus their preference structures.

However, there have been very limited rigorous empirical studies that explain how and to what extent the rise in the consumer concern over the health-related issues caused by the medical research results actually affected consumers meat purchasing behavior. It is difficult to get reliable time-series information on the evolution of attitudes of consumers toward health related-issues. Several studies on the linkage between health awareness and meat consumption hehavior have relied on cross-sectional data surveyed regionally which may or may not represent national trends(Menkhaus et al., 1993; Jenson et al., 1992; Riechers et al.; 1988). A coneptual base is needed for assessing how information is assimilated by consumers and how that information, once assimilated, is translated to behavior patterns(Myers, 1987).

One of the main objectives of this research is to conceptualize consumer behavior from a broad range of perspectives including marketing, psychology and sociology as well as economics, thereby unveiling the mechanism of preference formulation and change. Based upon that conceptual framework, this research will perform a comprehensive investigation into the empirical linkage between consumers concern about health and nutrition and actual meat consumption behavior, using attitudinal cross-section data surveyed nationally which will be described in detail later.

Another hypothesis of particular importance is the increased demand for convenience. The value of time has risen with increase in more than one member of a household working. In particular, for women the amount of time needed to cook could be a factor in consumer food purchasing decisions. Industry studies show that most consumers choose foods that can be prepared in less than 20 minutes(Buse 1987). A lot of white meats with increasingly processed forms can now be found in grocery stores or fast food establishments. Usually, highly processed products are convenient to prepare and take less time to cook. The increasingly processed forms of poultry have enhanced the substitutibility of poultry products for pork and beef(Eales and Unnevehr, 1988). The increased substitutibility and actually increased consumption of white meats may reflect some differences in convenience. Convenience is a valid factor explaining part of the changes in meat consumption patterns over the last two decades. This hypothesis, however, remains subject to empirical testing.

Additionally, when cross-sectional data are analyzed, the heterogeneity of demographic effects is clearly evident(Heien and Pompelli, 1988). Several cross-sectional studies of meat demand have identified demographic variables such as region, ethnic origin, education, sex, employment status of female head, and household size as having a statistically significant impact on meat consumption(Heien and Pompolli, 1988; Lee, 1987; McCracken, 1987). The impact of those demographic variables will be quantified in this study.

Objectives

This research is concerned with the observation that the causes of the trends in the meat consumption over the last two decades have not been fully explained, at least empirically. Specific objectives are as follows:

1) Set forth methods for measuring meat demand using consumer household data.
2) Estimate the impact of beef advertising on beef demand both in terms of becoming consumers and intensity of consumption.
3) Develop measures of consumer attitudes particularly relating to health concerns and show these impacts on meat demand.
4) Estimate the impact of demographics on meat consumption.
5) Provide simulations to illustrate the effects of direct and substitute prices on meat demand.
6) Using the estimated household serving models, derive the implicit value of the beef checkoff.

Scope and Limitations

This research will employ cross-sectional time-series consumer panel data set from a large survey of approximately 17,200 observations. The survey started in March, 1984, and entries are recorded on NPD waves closely corresponding with calendar months. The panel participants change from period to period; hence, time-varying parameter models are not appropriate. The panel data may be analyzed cross sectionally using selected periods, say one year. Alternatively, the whole range of data can be grouped to form a single pool of cross sectional recorded over time.

The data cover nine regions(New England, Mid-Atlantifc, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, and Pacific) and include the serving frequency of consumption of beef, pork, chicken, turkey, fish and other kinds of meat by household. Socio-demographic characteristics of each household are recorded along with consumers attitudes toward health-related attributes of meats and information about other food consumption practices. Thus, it is possible to relate the frequency of the consumption of the various meat to the socio-demographic characteristics of each household, to the attitudes toward health-related issues, and to specific behavior practices. The demand analyses will be restricted to fresh beef, pork, chicken, turkey, and fish. The analyses do not include consumptions of processed meat products.

The NPD survey data do not contain information on prices. Quarterly market price data from another source will be matched to each NPD wave to account for the effects of prices on purchasing decisions. Furthermore, information on beef promotion program efforts will be included in the beef model. Ward(1994) has found that the beef checkoff programs have positively contributed to the beef demand over the last decade, using time-series data.

There are two important limitations in the current research. First, it does not use disaggregated data for the meat consumption frequency. Market data reveal that the consumption of hamburger meat is on the rise, while steak consumption decreases. Consumption of processed chicken has increased consistently over the last two decades, while the consumption of whole birds declined. Hence, the results of current research must be interpreted in the context of aggregate demand and not specific meat cuts.

Second, the data do not distinguish between home and away from home consumption. The share of food expenditures for food-away-home rose from 26.6 percent in 1960 to 45.3 percent in 1990. In contrast, the share of food expenditure for food at home fell from 73.4 percent in 1960 to 54.7 percent in 1990(Capps, 1992). Consequently, identifying and measuring the influence of factors affecting away-from-home meat consumption behavior will be one of important future tasks of meat demand analysts. This study does not address this important issue since the reporting households do not identify where the consumption occurred.

Methodology

The basic methodological approach of this research will be the theory of consumer behavior from the disciplines of marketing and social psychology. Piggot and Wright(1992) support this approach with the observation that marketing theory is considered as a possible source of more explicit and flexible models of demand which may lead to a better understanding of consumption patterns and structural changes.

Since the main purpose of this research is to look into the hypothesized preference shifts away from old trends due to factors other than prices and income, this research needs to analyze preference formation and change which has been largely ignored by economics. Preference was defined as a set of attitudes earlier. There are several models explaining the linkage between attitude and behavior. The concept of a multiattributes model(Fishebin, 1975) among them will be used as a theoretical base in exploring how preference changes(changes in psychological variables) affect consumers purchasing behavior. That is, the linkage between the frequency of meat consumption and attitudinal responses of consumers about product attributes will be empirically shown.

In statistically analyzing and estimating the model, the nature of a dependent variable that is limited in range must be considered. In general, Tobit models(Tobin, 1958) are appropriate when the dependent variable is censored at some point. A usual censoring point is zero because survey data include a significant portion of zero reports on the consumption of various foods. Several extentions of the Tobit model are available such as double-hurdle or purchase-infrequency model(Cragg, 1971; Deaton and Irish, 1984; Blundell and Meghir, 1987; Haines et al., 1988). Purchase-infrequency model questions the assumption of the Tobit model that zero obervations represent traditional corner solutions. One argument is that zero expenditure reporting may occur because respondents can consume out of storage. The discrepancies between expenditures and actual consumption level are what the purchase-infrequency model is intended to reflect, whereas the double-hurdle model doubts that the same stochastic data generating processes or same independent variables and magnitudes of the parameters govern both of the decisions of whether to consume or not and how much to consume.

Cragg(1971) developed the first application of the double-hurdle model. Examples of the double-hurdle models include labor supply function estimation and demand equation estimation for cigarettes, butter, milk and shellfish.

Purchase-infrequency models are useful when commodities are storable and survey periods are too short to record purchases. This study can not use the purchase-infrequency model because the dependent variable is the number of eatings of meat in two weeks. Consumption out of storage is included in the recorded frequencies. Hence, a preliminary judgment is that the double-hurdle model seems appropriate for the current problem and data.

CHAPTER 2
LITERATURE REVIEW OF EMPIRICAL STUDIES

Overview

The motive of this study was the perceived inability to obtain a clear explanation for the observed changes in per capita consumption of meat products. And, studies of structural changes in meat consumption patterns and their results were part of the rationale of why the present research is needed. Besides the three factors of increased health and nutrition consciousness of consumers, increased demand for convenience, and changing demographic profiles, there are other explanations of the changed meat consumption pattern not referred to in the previous chapter. Although a majority of the studies of structural changes have proved that consumer preferences have deviated from old long-term trends, there are still papers asserting that preferences for meat have not undergone structural changes. Hence, it will be informative and worthwhile to review how those studies explained the changes in meat consumption patterns. Nyankori and Miller(1982), Braschler(1983), Chavas(1983), Thurman(1987), Eales and Unevehr(1988), Moschini and Meike(1987), Sakong and Hayes(1993) present evidence of structural change in the 1970s, while studies by Haidacher et al.(1982), Moschni and Meike(1984), Dahlgran(1987), Chalfant and Alston(1988), and Eales and Unnevhr(1993) found no such evidence. Development of methodological techniques to detect structural changes in meat demand has been noticeable throughout the studies. Detailed explanations about this methodological evolution will not be provided here.

While clear consensus on the shift of preferences away from old consumption trends has not been reached, the bottom-line implication of the studies of structural changes is that it is necessary to formally investigate the suspected sources of structural changes(Capps, 1991). There have been increasing medical research findings about the negative linkage between fat and cholesterol intake and heart disease convincing researchers that it is necessary to examine the linkage between the new findings and meat consumption. Several researches dealing with that linkage will be reviewed in the third section.

Demographic variables are one of the oldest non-economic variables to be incorporated into food demand analysis. The fourth section will consider those papers supporting the hypotheses that changes in demographic profiles have contributed to the declining beef and increasing poultry consumption.

A final section will be given to the review of papers that tested the validity of double-hurdle specification or two-step decision process and other extended Tobit models in food demand analysis. Labor force economists have long found that labor force participation decisions should be analyzed separately from hours worked decisions(Haines et al., 1988). Along with the labor force economists, applied demand economists have been serious for the last decade in applying the two-step decision process to food consumption behavior, since ignoring the two-step decision process might miss the true behavioral patterns and can lead to erroneous policy recommendation. The food items analyzed so far include butter, cheese, cigarette and milk. Although there has been no application of the two-step decision process into meat consumption behavior, it appears to be logical that certain tastes, preferences and other determinants(e.g, vegetarianism, health concerns, or religion) can affect the yes/no decision significantly but have no impact on the intensity of the meat consumption. Thus, before we test the validity of the double-hurdle specification in meat consumption behavior, it will be useful to review the results of the application of double-hurdle specification in labor supply equation and other food demand models. Statistical details for the double-hurdle model will be handled in Chapter 5.

Structural Changes in Meat Demand

Recognizing that such factors as seasons, advertisement, taste, public policy, or business cycles make demand relationships change over time, Nyankori and Miller(1982) tested hypotheses concerning structural changes in the demand for beef, chicken, turkey and pork. They found that structural change occurred in the demand for beef and chicken, but not in the demand for turkey and pork. However, any causes of the structural change specific to meat demand were not advanced.

Brascher(1983) indicates that errors in price forecasts for both pork and beef in the 1970s were substantially larger than those of the 1960s. He hypothesizes that the general economic setting of the 1970s, including oil embargo, energy shortages and high inflation, has caused structural demand changes for food and the larger errors in price forecasts for beef and pork. To test the hypothesis, he estimates price-dependent demand models for beef and pork with the annual data of 1950-1982 period. He determines when the structural shifts in demand over the 33-year period occurred by the method of switching regression analysis. The switching regression model divides an overall time period into two periods, estimates the two equations and gets error sums of squares for each period. The procedure then varies the choice of the two periods and the dichotomy of periods resulting in a minimum sum of error of squares for the two periods is chosen. The year of 1970 gave the minimum sums of error of squares. Chow test confirmed that regression coefficients for each period of 1950-1969 and 1970-1982 were different for both beef and pork.

While the above two studies adopted old techniques, Chavas(1983) used more sophisticated and rigourous models to test for parameter constancy. Assuming that parameters can change randomly from one period to the next, he used Kalman filter specification to identify and estimate(update) parameter change in a linear demand model with 1970-1979 annual data. In his study, important structural change was identified for poultry and beef, but not for pork demand in the late 1970s, suggesting that data before 1975 may not be very useful in measuring poultry and beef demand in the 1980s. Income elasticity of beef sharply dropped from .655 in 1975 to .183 in 1979. In contrast, income elasticity of poultry increased from .012 in 1975 to .275 in 1979. The dramatic changes in income elasticity in both cases reflect that structural change may have occurred. Chavas suggests that the recent concern of consumers about fat and cholesterol may have produced an important shift in meat preference.

The debate concerning possible structural change in meat consumption got heated when Moshini and Meike(1984) argued against the structural change and maintained that variation in prices and income could rationalize the changes in meat consumption trends. They tested for parameter stability in an estimated beef demand equation for a period from 1967 to 1987. While they acknowledge that providing a definite answer to the question of whether there has been a change in the structure of consumer preferences affecting U.S. beef consumption is difficult especially because this hypothesis can be confused with many types of model misspecifications, they conclude that the evidence of structural change is weak. They attribute the decline in beef demand to changed market conditions(relative prices and income), thus take it a reversible nature.

Since then, researchers have made significant efforts to refine the empirical models and data use. Those efforts include tests for endogeneity of price or quantity(Thurman, 1987; Eales and Unnevehr, 1993; and Dahlgran, 1988), use of disaggregated data(Eales and Unnevehr, 1988), adoptions of nonparametric method and technological change theory from production economics(Chalfant and Alston, 1992; Choi and Sosin, 1993)).

Thurman(1987) note that empirical demand analysis requires two hypotheses auxiliary to those required by economic theory. The first one is the hypothesis of stable preferences, and the second hypothesis is related to the specification of the stochastic structure of prices and quantities to justify the use of a particular estimator. To test the second hypothsis, he did an endogeneity test and found that, for poultry demand, price is predetermined by cost of production, which is consistent with competitive market structure, while quantity is determined by price(demand). Also, he tested the first one and found evidence of an outward shift in poultry demand in the early 1970s. He suggested that the introduction of specialized franchise chicken restaurants may be the cause of the outward shift of the poultry demand.

Eales and Unnerehr(1993) indicate that, since red meats are perishable and produced with a long biological lag, quantity supplied is likely predetermined and quantity-dependent models may be inappropriate. Thus, they tested the endogeneity of meat prices and quantities in AIDS(almost ideal demand systems) and inverse AIDS model. To consider the supply side of the meat market in the test, they included livestock production cost determinants and technological change indicators in the system. They found that both prices and quantities appear to be endogenous within the entire meat market, reinforcing the notion that price and quantity are determined simultaneously. Without the supply side variables, AIDS model detects structural change in meat demand in the mid-1970s. However, 3SLS estimation of AIDS and inverse AIDS with the supply side variables eliminates the evidence of a mid-1970s demand change. Their consequent conclusion is that changes in supply-side conditions explain much of the apparent mid 1970s shift in beef and chicken consumption.

Eales and Unnenehr(1988) were the first ones that used disaggregated data to test for structural changes. Observing that the share of broiler slaughter marketed as whole birds declined from 74 percent in 1965 to 28 percent in 1985, while cut-up parts and processed chicken products increased from 26 percent to 72 percent, they raise two related questions in their paper: First, do consumers allocate expenditures among meats by animal origin or by-product type? Second, does disaggregation of meat into products in a meat demand model give insight into the causes of structural change? To answer these questions, they estimated two demand systems with the almost ideal demand system. The first system includes aggretate chicken, beef, pork, and the second system disaggregates chicken into whole birds and parts/processed products, and beef into hamburger and table cuts. As a result of the estimation of the two systems, they rejected the hypothesis that consumers allocate expenditures first to animal product aggregates such as beef or chicken, and then among products within an aggregate. That is, consumers allocate expenditures across all meat products at once or between high quality and low quality products from different animals. They warn that use of aggregate chicken and beef could bias estimation of demand parameters and hence tests for structural change. Accordingly, they conducted tests for structural change in disaggregated products. The result identifies two types of significant shifts in meat products: an exogenous constant annual 6.4 growth in demand for chicken parts/processed from 1965 to 1985 and a 3.5 percent decline in demand for beef table cuts after 1974. Over the entire period, demand for whole birds declined slightly and demand for hamburger increased slightly. With this disaggregated data, they refuted Chavas's hypothesis that health concerns have been the driving force behind the shift from beef to chicken, because a shift in demand due purely to health concerns would have led to growth in whole birds and a decline in hamburger, which they did not find. Finally, they conclude that the shift from beef table cuts to chicken parts/processed must have been caused by growth in demand for convenience, suggesting the chicken industry has responded to these changing preferences through marketing new products.

Moschini and Meike(1989) test the hypothesis of structural change in U.S. meat demand with almost ideal demand system with parameters following a gradual switching regression model. Their results support the idea that the observed meat consumption patterns of the last two decades cannot be fully explained by the dynamics of prices and income. Structural change is biased against beef, neutral for pork, and in favor of chicken and fish. While their analysis does not identify the roots of this bias, they argue that this movement toward an increased importance of white meats further supports the idea that dietary concerns are partly responsible for the perceived changes in meat consumption patterns. They advise the beef industry to adjust quality in production and to increase efforts in promotion and marketing.

So far, every analysis had to assume specific functional forms to estimate demand models and test for potential changes in the underlying utility function. The nature of relationships between variables in demand models is intrinsically unknown. Chalfant and Alston(1988), warning about using a particular functional form, focus on a nonparametric method for testing whether market demand has shifted because of a change in tastes. According to them, the advantage of this approach is that it gives a test for stable preferences for market goods that does not require that they be of a particular form such as translog. They applied the technique to the demand for red meats using time-series data from the United States and Australia. They checked for consistency with the axioms of revealed preference. When consumers obey the Strong Axiom of Revealed Preferences(SARP), there is a stable demand system that fully explains observed comsumption patterns. This holds because the strong axiom is equivalent to the existence of a well-behaved utility function. The axiom does not need hold in the data when structural changes occur. They showed that the data from both countries could have been generated by stable preferences. Therefore, they concluded that any results from these data sets that tastes have changed must come in the form of restrictions on the nature of demand systems, and that relative price can account for the observed shifts in consumption patterns.

Choi and Sosin(1990) introduces a method with roots in technological change theory for identifying, measuring, and testing for structural change in the preferences of consumers. In their study, structural change is specified as a time-varying multiplicative term within an underlying consumer utility function. They use translog flexible functional form specification for the underlying utility function to develop the equations for estimation. Their results confirm the existence of structural decline in U.S. red meat demand since the early 1970s.

In summary, the majority of the studies concluded that preferences for meat consumption were not stable over the last two decades. While health concern was the most frequently hypothesized cause of the unstable utility function, use of disaggregated beef and chicken data revealed that growth in demand for convenience was the real cause of the changes in meat consumption pattern. Supply side changes in the beef industry has been cited as alternative sources for the seeming structural changes in meat consumption.

Linkage Between Health Concern and Meat Consumption

In his 1992 SAEA presidential address, Capps emphasized health and nutrition issues in food demand analysis as one of important future agenda of agricultural economics, quoting from a 1990 Gallup survey that the vast majority of consumers recognize that what they eat may affect their future health. Methodologically, there are two ways to investigate the linkage between health issues and food purchasing behavior. The first one is to use time-series information on health and nutrition issues(Capps, 1992: Ward, 1993), and the second is to utilize cross-sectional attitudinal variables or direct questions about the importance of the effect of health issues in meat purchasing decisions.

Capps(1992) was quick to incorporate the time-series index of cholesterol information in demand system which has been prepared by Brown and Schrader(1990) to investigate simultaneously the impact of prices, total expenditures, and cholesterol information on the consumption of beef, pork, poultry and fish. He found that, in the beef and pork equation, the coefficients associated with the cholesterol information index variable were negative. Also, as expected, the coefficients were positive for poultry and fish.

Menkhaus et al.(1993) recognizes that ready to cook, microwaveable, low sodium, low fat, and low cholesterol are product attributes which have become more prominent on labels. They hypothesize that these and other characteristics likely affect perceived quality and the resulting preference for food products. They identify tenderness, degree of gristle and waste as other attributes of beef. To test the hypotheses, they employ a data set collected from two areas, Denver and Los Angeles, respectively during May and August, 1989. The total number of observations included in their analysis was 741. The dependent variable in the model, perceived quality, was coded fair or poor(0), good(1), excellent or very good(2). The independent variables measure respondents' concern(0) or dissatisfaction about above mentioned attributes of beef. Perceived characteristics pertaining to health and convenience were found to be important factors influencing the quality perceptions of beef, but not for the tenderness, degree of gristle and waste. Consequently they concluded that concern about health and convenience may be likely factors contributing to the recent decline in beef demand.

Riechers et al.(1988) examine and analyze changes in meat consumption patterns in seven Lousiana metropolitan regions with cross-section data which describe demographic characteristics and give seven reasons of decreasing red meat consumption(these questions apply only to households reporting decreased beef consumption). Respondents ranked "concern with beef's influence on health and well-being" as the number one cause of reduced beef consumption.

Capps et al.(1988) examine consumer willingness to try lean meat products from a particular retail food chain in Houston. The objectives of their study were twofold: 1) to isolate demographic and psychographic characteristics related to the selection of lean meat products, and 2) to identify target groups inclined to select lean meat products. In their analysis, factors important in the decision by consumers to try lean meat products in several retail food stores in Houston were: 1) age, 2) residency in Texas, 3) education level, 4) household size, and 5) predisposition to buying lowfat foods(fat consciousness). They suggest that this information can be used to identify target groups inclined to purchase lean meat products.

Menkhaus et al.(1988) recognize that the beef industry is placing more emphasis on marketing products with specific characteristics appropriate to particular consumer segments. Traditionally, a commodity oriented approach has been dominant. Since the shift in emphasis has implications with respect to the types of information needed by the beef industry to be used in promotion campaigns and for marketing beef, they try to identify factors which are important in influencing purchase and reorder decisions of a branded, low fat, fresh beef product. They found that health related factors and visual differences significantly influence the probabilities of reordering and puchasing.

Baumer(1987) employs a perceptual mapping, a modern marketing research technique to examine significant factors on the demand for meat products. He finds perceptual mapping a useful technique for summarizing the notion of matches between preferences and products. It makes use of survey data for the computation of results. He also notes that, unlike empirical data, survey research allows us to investigate all the possible influences on the demand for meat through direct questioning. An objective of perceptual mapping is the communication of a large amount of information using just one diagram. To use perceptual mapping, researchers need to identify, a priori, the important factors influencing demand for the products. He identifies price, calories, cholesterol, saltiness, taste, convenience, ease of digestion, saturated fat, and nutrition as important attributes of beef, poultry, pork, fish, and shellfish. The result shows that most people who viewed beef as being high in calories also viewed beef as being high in saturated fat. It also revealed health concerns as being more important than price in the selection of meat. Chicken was viewed as convenient, low in price and tasting good. He compared actual caloric and cholesterol levels of meat products with the survey data, and finds that red meats may be unduly tagged with a negative health image at least for some cuts of meat. The comparison suggests that the potential exists for improvement by pork and beef through a promotion campaign that clarifies some consumer misapprehensions.

Ward(1993) incorporates an index of consumer concerns for fats, cholesterol and preservatives derived from a NPD attitudinal survey data set of 1984-1992 period into his analysis of measuring the impact of beef check-off programs on beef demand. His previous analysis has allowed the time trend variable(T) to capture changes in preferences, the effects of everything else other than prices, income and the advertising expenditure. The first step to derive the index was to tabulate the percentate of consumers expressing strong to moderate concerns for fats, cholesterol and preservatives and to show that the three data series moved in a similar way. In the second step, he uses principal component procedures to eliminate the correlations among the three data series and derive two indices for health concerns. The first health index(the first principal component) included 84 percent of the health information found in the original variables while both indices combined to account for 96 percent of the information in the original variables. While the health indices turned out to be significant in the beef demand model, he indicates that increased availability of other meats in new forms, the desire for convenience, and increased consumption away from home might be factors that contribute to part of the measured decline in beef demand during the 1980s.

Socioeconomic and Demographic Effects

Economists have long been interested in incorporating socioeconomic and demographic variables in demand analysis, because they wanted to tackle the problem of ceteris paribus assumption in demand analysis. Socio-demographic variables were the most easily imaginable and accessible factors other than prices and income that influence consumption behavior. In this case, the objective of research is to explain and predict comsumption with no attempt to measure welfare. Another incentive came from policymakers charged with making welfare programs more effective. Welfare comparisons provide the rationale for different treatment of family types on income tax schedules, income maintenance programs, or government food programs(Raunikar and Huang, 1980).

The most convenient way of incorporating demographic variables into demand analysis is to simply include demographic variables on the right hand side of ad hoc models of the demand for individual goods(Lewbel, 1985). This procedure allows for inclusion of as many variables as wanted and available. Pollak and Wales(1981) discuss five general procedures for incorporating demographic variables into classes of demand systems: demographic translating, demographic scaling, Gorman procedure, the reverse Gorman procedure, and modified Prais-Houthakker procedure. Unlike the ad hoc method of putting demographic variables on the right hand side, the procedures satisfy the theoretical restrictions that demand theory imposes.

Recently, there has been some suspicion that the changing demographic profile of the U.S. population and changing life-styles of consumers have had impacts on demand for meat, thus possibly contributing to the changed meat consumption pattern, even though there is no way to verify the latter statement.

Heien and Pompelli(1988) estimate economic and demographic effects on the demand for disaggregated beef such as steak, roast, or ground beef, using an AIDS(almost ideal demand system) model. While price and expenditure elasticities of demand was derived for each of the three beef cuts, another purpose of their analysis was to identify the major demographic factors responsible for the changing beef market shares of the three major retail cuts. Household size, region, tenancy, and ethnic origin were identified to have strong effects on the demand for the disaggregated beef cuts.

Lee(1987) employs the USDA's 1977-1978 Nationwide Food Consumption Survey(NFCS) data to investigate the demographic and socioeconomic factors which determine consumer's discrete choice of whether to consume red meat at home or not, and the consumer's choice of how much to spend on red meat consumption at home, and the number of different red meat products consumed at home. Two models were developed and estimated which permit calculating the probability, expenditure, and different red meat items of a household with a particular set of characteristics buying red meat for at-home consumption. The dependent variables are the decision to consume red meat, the amount of red meat expenditure, and the number of different red meat products consumed at home. As for the decision to consumer red meat, his analysis showed that households located in central cities would be less likely to consume red meat at home than those in rural and suburban areas, that the presence of a male or a female head in the household would increase the likelihood of consuming red meat at home, and that the households with female heads are more likely to consume red meat at home than those with a male head.

Double-hurdle Specification in Food Consumption Behavior

Blundell and Meghir(1987) compared Tobit estimates to double-hurdle estimates for a married women's labor supply function. Since the double-hurdle model nests the Tobit model, they conducted a likelihood ratio test and overwhelmingly rejected the Tobit model. This result indicates that married women are responding differentially given the explanatory variables with respect to the decisions of labor market participation and of the hours worked. It reinforces the economic intuition that labor market participation and hours worked are two separate decision processes. This intuition seems especially true when the dependent variable analyzed is married women because they can opt to be full-time housewives.

Blisard and Blaylock(1993) applied Tobit, double-hurdle and purchase-infrequency models to the analysis of butter expenditures to determine which model describe butter consumption behavior most appropriately. They tested it by using a Voung's model selection method whose test statistic is based upon likelihood ratio tests. Two hypotheses suggested were market participation model against purchase-infrequency model and market participation model against Tobit model. The test revealed that butter purchases are better modeled by the purchase infrequency model than by the market participation model. In turn, the market participation model was found to be preferred to the Tobit specification. The first hypothesis test result suggests that when survey data are used for demand analysis, the possibility of a nonpurchase record because of the short period of survey should be taken into account. Also, the second test shows that the Tobit model is inappropriate to capture whether a consumer is participating in the market or not.

Haines et al.(1988) questioned the assumption of the Tobit model that the decision to consume a given food item is the same as the decision about the amount of the food to consume, and used a two-step decision process to analyze the behavior of high and low fat milk group and high fat, low-fiber bread group consumption. Their analysis shows that the determinants of the decision whether to consume from a particular food group are often not the same as the determinants of how much to consume. As a result, the two-step decision process method was shown to be able to provide additional information on what factors are significant in increasing or decreasing the probability of market participation.

Lin and Milon(1993) supported the importance of the double-hurdle model in food demand modelling by rejecting the Tobit model via Voung's method in shellfish(oyster and shrimp) consumption model. There were several variables which had a significant effect on the market participation equation(probit equation) but not on the consumption equation. For example, taste perception was highly significant determinant of oyster participation and consumption decisions, but it influenced shrimp participation only. Cost perceptions negatively influenced oyster consumption but did not affect participation in the oyster market. Based on the two-step decision processes estimation, they were able to derive the following story. The decision about whether to consume oysters was primarily determined by taste perception, and once that decision was made, taste, nutrition, and cost perceptions determined consumption frequency. As Haines et al(1988) indicated, the findings can be very important additional information to the marketing strategies of fish industry.

Gould(1992) estimated a purchase infrequecny model for the analysis of cheese consumption in U.S., giving attention to the possibility that the purchase cycle of cheese might be longer than the survey period length, and then a zero expenditure level may not correspond to zero consumption. If it is the case, Tobit specification should be inappropriate because the Tobit model considers zero obervations as true corner solutions. He tested and rejected the null hypothesis that the Tobit specification adequately models demand for cheese vis-a-vis the purchase-infrequency model. Additional information he found was that income significantly impacts consumption but does not influence purchase probability. This result supports the idea of multistage analysis of the consumption process. In conclusion, none of the above studies found Tobit model superior to double-hurdle models. This finding implies that multistage decision making processes should be a fairly standard method in food demand analysis when survey data is employed that includes a substantial portion of zero reports.

CHAPTER 3

OVERVIEW OF NPD DATA AND DESCRIPTION OF VARIABLES

As explained in the first chapter, this research addresses primarily the effects of attitudinal, behavior and demographic variables on meat consumption. Since these types of variables are not available from USDA market data sources, alternative private data from a consumer panel will be utilized(NPD Group). The National Panel Diary Group is an independent company that maintains a panel of consumers across the U.S. with the purpose of recording changes in consumption behavior and attitudes. The NPD maintains a continued survey of consumers who report mainly their concerns for various aspects of health issues(attitudinal variables), convenience, and demographics along with the frequency of their meat consumption. In excess of 17,000 data points are recorded periodically across consumers for the years since 1984.

Consumers generally rank their concerns on an ordering scale of six categories: completely agree, agree mostly, agree somewhat, neither agree nor disagee, disagree somewhat, or disagree mostly. This scale is applied to questions such as "a person should be cautious about cholesterol." A selected list of the questions is shown below.

Questions on Taste

Food should look, smell, and taste good

Questions on Convenience

Convenience is most important

Questions on Health and Nutrition

Depend mostly on canned foods

Important for foods to be fresh

Know more about nutrition than most

A person should be cautious about

- Cholesterol
- Additives
- Fat
- Preservatives
- Caffeine

Questions on Diet and exercise

Overweight is not Attractive

Love to swim

Conscious of Calories

Like to Lose Twenty Pounds

Doctor Gives Advice and Diet

Questions on Preparation and Snacking

Avoid Snacking Entirely

Avoid Fried Foods

Check Labels for Harmful Ingredients

The following set of questions are about food and beverage consumption patterns, and ranked using six categories: always encourage, almost always encourage, sometimes encourage, neither encourage nor discourage, sometimes discourage, almost always discourage.

Consumption Pattern of Food and Beverage

Consumption of Hot Dog Sandwich

- Whole Milk

White Bread

Skim/low fat Milk

Magarine

French Fries

Lunch Meat

Pizza

Taste and convenience are presumed to be salient attributes of meat consumption. Questions on health and nutrition provide attitudes towards health-related variables which are relevant for meat consumption, while the other sets of questions give consumer characteristics about general food and beverage consumption pattern preferncces.

The next section gives names and definitions of selected variables relevant for this research. The third section explains the procedures of removing correlations among variables and gives principal component analysis for two sets of variables that were identified to be highly correlated. The remaining sections will describe summary statistics of dependent and attitudinal variables to provide some preliminary insights about the characteristics of NPD data.

Description and Definitions of Selected Variables

Specific variables relevant for the objectives of this study include frequencies of household servings of beef, pork, chicken, turkey, and fish, household characteristics(demographics), health-related attitudinal variables, and other psychological variables related to general eating habits. Household servings are divided by household size to define per capita servings, which will be used as dependent variables for this study. Table 3-1 provides selected variable names and their definitions.

Table 3.1 Descriptions of Selected Variables in the NPD Data Set

Variables	Definitions
DEPENDENT	
CNBEF	number of household eatings of beef in 2 weeks
CNPOR	number of household eatings of pork in 2 weeks
CNCHK	number of household eatings of chicken in 2 weeks
CNTUR	number of household eatings of turkey in 2 weeks
CNFSH	number of household eatings of fish in 2 weeks
DEMOGRAPHICS	
DMHSZ	demographic household size(1=1 member, 2=2 mem, 3=3/4 mem, 4=5+ mem)
DMMSZ	market size(1=1 million+, 2=500/999 m, 3=250/499 m, 4=50/249 m, 5=rural)
DMCHL	presence of children under 18 years(1=yes, 2=no)
DMFEM	employment of female head(1=employed, 2=not employed)
DMAGE	age of female head(1=<35, 2=35/44, 3=45/54, 4=55/64, 5=65+)
DMEDU	education of female head(1=no high school, 2=high, 3=some college, 4=college graudate)
DMREG	census region(1=NE, 2=MA, 3=ECN, 4=WNC, 5=SA, 6=ESC, 7=WSC, 8=MTN, 9=PAC)
DMINC	household income(1=under $10000, 2=10/19999, 3=20/29999, 4=30/39999, 5=40/49999, 6=50/59999, 7=60/6999, 8=70/79999, 9=100000+)
DMPCI	per capita income(in thousands 06=$6000)
DTFEM	adult female on diet(yes or no)
ATTITUDINAL VARIABLES*	
ATDOC	doctors gives advice on diet

Table 3.1 Continued

ATTITUDINAL VARIABLES	
ATSNK	avoid snacking entirely
ATLAB	check labels for harmful ingredients
ATSWM	love to swim
ATWGT	overweight is not attractive
ATCAC	conscious of calories
ATLBS	like to lose 20 pounds
NTCHL	a person should be cautious about cholesterol
NTFAT	a person should be cautious about fats
NTADD	a person should be cautious about additives
NTPRE	a person should be cautious about preservatives
PRCOV	food preparation convenience
NTKNO	know more about nutrition than most
NTPLN	plan nutritious meal
NTLOK	most important foods look, smell, taste good
FDSKM**	skim/low fat milk
FDHOT	hot dog sandwich
FDLUN	lunch meat
FDPIZ	pizza
FDFFR	french fries
FDTAC	tacos
FDFCH	fried chicken

* 1=completely agree 2=agree mostly 3=agree somewhat 4=neither agree or disagree 5=disagree somewhat 6=disagree mostly

** 1=always encourage, 2=almost always encourage, 3=sometimes encourage, 4=neither, 5=sometimes discourage, 6=almost discourage

Principal Components Analysis

For many questions it is probable that responses are highly correlated. As an example, concerns for health effects of fats and cholesterol are highly correlated. In those situations where variables can be grouped, it may be more desirable to create an index variable representative of the information found within the group. Procedures such as principal components provides one avenue for creating an index from the highly corrlelated variables(see Ward, 1994: and Dunteman, 1989). In these cases the index rather than the actual variables may be included in the analysis.

To illustrate the principal components method, assume the classical linear model

$$Y = X\beta + U \tag{3-1}$$

where β is a k * 1 vector of unknown population parameters to be estimated associated with the independent variables contained in the (n*k) X matrix and the u vector contains random disturbances normally distributed. Let W be the k*k matrix consisting of K*1 orthonormal characteristic vectors(w_i) of the correlation matrix (X'X). Then, the n*k matrix of principal components has the following relation to X.

$$Z = XW \quad \wedge \quad ZW' = X \tag{3-2}$$
$$\textit{here,}\ W^{-1} = W' \ \textit{by orthogonality}$$

Substituting equation (3-2) into equation (3-1) for X, the relationship between Y and the principal components is defined as,

$$Y = ZW'\beta + U = Z\beta^* + U \tag{3-3}$$

where $\beta^* = W'\beta$ is the k*1 vector of population parameters corresponding to the principal components Z. The OLS estimate of B* can be written as

$$\begin{aligned} \beta^* &= (Z'Z)^{-1}Z'Y \\ &=(W'X'XW)^{-1}W'XY \\ &= W'(X'X)^{-1}WW'X'Y \\ &= W'(X'X)^{-1}X'Y \\ &=W'\beta \end{aligned} \tag{3-4}$$

Hence, the OLS estimates of the original parameters in equation (3-1) can be recovered as

$$\beta = W\beta^* \tag{3-5}$$

To see the recovering process of original parameters in greater detail, let's assume the following principal components regression model.

$$Y = \beta_0^* + \beta_1^* Z_1 + \beta_2^* Z_2 + . . . + e \tag{3-6}$$

Note that the Z_i's are completely orthogonal. Substituting for the Z_i, the equation can be expressed in terms of the orginal variables as shown below

$$Y_t = \beta_0^* + \sum_j(\beta_1^* W_{1j} + \beta_2^* W_{2j} + . . . + \beta_j^* W_{jj})X_{jt} + e_t \tag{3-7}$$

Then, the marginal effect of the variables X_{ji} on Y_i could be expressed as

$$(3\text{-}8) \qquad \frac{\partial Y_i}{\partial X_{ji}} = \beta_1^* W_{1j} + \beta_2^* W_{2j} + \beta_3^* W_{3j} \; . \; . \; . \; . \; \beta_j^* W_{jj}$$

which is exactly an expanded form of equation (3-5).

Usually the principal components estimator of β is obtained by deleting one or more of the variables Z_i. The most common criterion of deleting some of the principal components is based on eigenvalues(characteristic roots). This criterion eliminates components having small characteristics roots(Mittelhammer and Baritelle, 1977). This criterion is desirable in the sense that components having small characteristic roots account for only a small part of the variation in the X variables. Let's see this property through the decomposition of the total variation(TV) in the X variables.

$$(3\text{-}9) \qquad \begin{aligned} TV(X) &= tr(X'X) = tr(X'XWW') \\ &= tr(W'X'XW) = T\,tr\Lambda \\ &= T\textstyle\sum_{i=1}^{k} \lambda_i \end{aligned}$$

Here, W was used to diagonalize (X'X)/T. The TV in the components Z is equal to TV(X), since W'X'XW = Z'Z. Therefore, the proportion of the total variation in the data set that is accounted for by the ith component is given by,

$$\begin{aligned} \frac{V(Z_i)}{TV(Z)} &= \frac{T\lambda_i}{T\sum_j \lambda_j} \\ &= \frac{\lambda_i}{\sum_j \lambda_j} \end{aligned}$$

The smaller is the characteristic root λ_i, the smaller is the proportion of the total variation accounted for by component Z_i.

For the cross-sectional demand analyses of beef, pork, chicken, turkey and fish, two sets of independent variables were identified to be highly correlated. The first set is made of attitudes toward health related variables, that is, NTFAT, NTCHL, NTADD, and NTPRE. The second set is composed of FDHOT, FDTUR, FDPIZ, FDLUN, AND FDTAC which represent general eating habit or behavior of consumers. Correlation matrix of the two sets are tabulated in Tables 3.2 and 3.3

Table 3.2 Correlation Matrix of Health-Related Variables

	NTFAT	NTCHL	NTADD	NTPRE
NTFAT*	1.0000			
NTCHL	0.7861	1.0000		
NTADD	0.7290	0.6985	1.0000	
NTPRE	0.6867	0.6378	0.8360	1.0000

* See Table 3.1 for definition of the variables

Table 3.3 Correlation Matrix of General Eating Behavior Variables

	FDHOT	FDPIZ	FDLUN	FDTAC	FDFCH
FDHOT*	1.0000				
FDPIZ	0.5819	1.0000			
FDLUN	0.7189	0.6138	1.0000		
FDTAC	0.5617	0.6538	0.5908	1.0000	
FDFCH	0.6341	0.5826	0.6699	0.6195	1.0000

* See Table 3.1 for definition of the variables

If the highly correlated raw variables are used in regression analysis, it becomes quite hard to distinguish the effect of one variable from that of other variables. In extreme cases where the variables have exact linear relationships, it is not possible even to get estimates because cross-product matrix of the explanatory variables(X'X) is not invertible. Principal components procedures provide new set of orthogonal explanatory variables(Z) as weighted combinations of original ones, weights being characteristic vectors(W), or factor loadings. Figuring out the number of new variables that should be included in the regression analysis can be based on eigenvalues of each principal component. The eigenvalues for the two sets of variables are shown in Tables 3.4 and 3.5. The variance of the first principal component of the health-related variables is 3.1880, explaining 79.7 percent of the total variance of the four variables.

Table 3.4 Eigenvalues for the Health-Related Variables

Principal Components	Eigenvalues	Cumulative R-squared
Z1	3.1880	0.7970
Z2	0.4433	0.9078
Z3	0.2105	0.9604
Z4	0.1210	1.0000

Table 3.5 Eigenvalues for the General Eating Behavior

Principal Components	Eigenvalues	Cumulative R-squared
Z1	3.4921	0.6984
Z2	0.5197	0.8023
Z3	0.3894	0.8802
Z4	0.3238	0.9450
Z5	0.2748	1.0000

The factor loadings for the two sets of variables are given in Tables 3.6 and 3.7. In the first principal components of both groups, the weights(factor loadings) are about equal so that each variable is about equally represented in the linear composite. Hence, the first principal component of the health-related variables could be interpreted as a measure of general concern about health. Note that the last two factor loadings of the second principal component have negative signs, while the weights for concerns about fat and cholesterol have positive signs. The opposite signs might suggest a contrast between concerns about more prominent attributes of red meat and concerns about less clear attributes.

Table 3.6 Factor Loadings for the Health-Related Variables

	Z1	Z2	Z3
NTFAT*	0.8966	0.2714	0.3499
NTCHL	0.8726	0.3887	-0.2900
NTADD	0.9156	-0.2616	-0.0633
NTPRE	0.8856	-0.3873	-0.0030

* See Table 3.1 for definition of the variables

Table 3.7 Factor Loadings for the General Eating Behavior of Consumers

	Z1	Z2	Z3	Z4
FDHOT*	0.8382	0.3584	0.1929	0.2048
FDPIZ	0.8191	-0.3603	0.3367	-0.2864
FDLUN	0.8631	0.2767	0.0967	0.0036
FDTAC	0.8172	-0.4147	-0.1820	0.3539
FDFCH	0.8400	0.1129	-0.4431	-0.2731

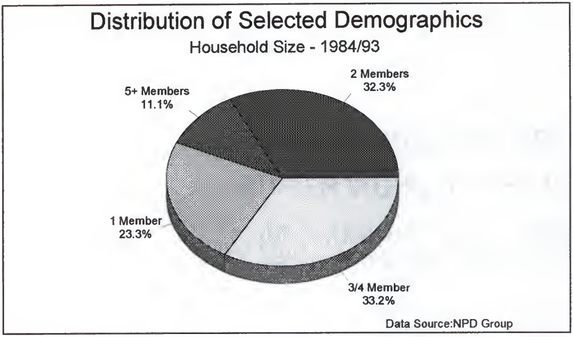
* See Table 3.1 for definition of the variables

Descriptive Statistics of Demographic Variables

The Household Size is categorized from 1 member to more than 5. Two to four member size occupied more than 65 percent of the total households, while '5 plus' took only 11 percent. Thirty five percent of the whole panels are living in metropolitan areas which have a population size of 1 million or more, and 36.5 percent in mid-sized cities of 999,000 - 50,000 population size. Rural areas occupied 27.8 percent. About half of the female head are employed and approximately 28 percent of the female heads are below 35 years of age. The next biggest percentage is taken by the category of 35-44 with 21.3 percent. With regard to education, about 55 percent of the female heads had education higher than high school, while only 8.8 percent had no high school education. While about 45 percent of the entire samples had income of $20,000 - $49,999, 41 percent had income below $19,999. High income households who earn more than $60,000 occupied about 7 percent of the total number of households. Figures 3.1 through 4 visualize the distribution of selected demographic variables and Table 3.8 shows descriptive statistics.

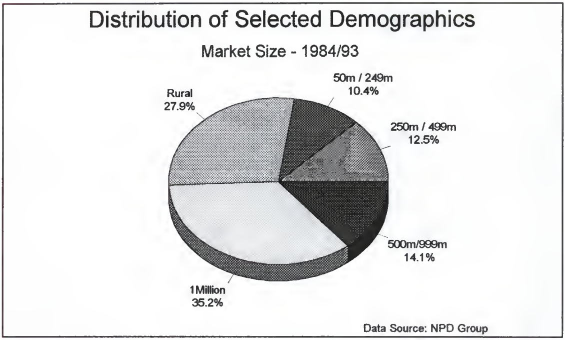
Descriptive Statistics of Attitudinal Variables

With regard to the question of 'a person should be cautious about fat'(NTFAT), 50.9 percent of the respondents replied with 'completely agree' and 22.9 percent with 'mostly agree'. Approximately 17.8 percent said that they agree less strongly. Only 9 percent answered that they diagree or are indifferent about fat intake. Replies to the question of 'a person should be cautious about cholesterol' showed similar patterns with the question about fat. About the question of 'a person should be cautious about calories', 20 percent strongly agreed, and 14.1 percent neither disagreed or agreed. Concerning the question of 'check labels for harmful ingredients', 40.9



Data Source:NPD Group

Figure 3.1 Distribution of Selected NPD Demographics; Household Size - 1984/93



Data Source: NPD Group

Figure 3.2 Distribution of Selected NPD Demographics: Market Size - 1984/93

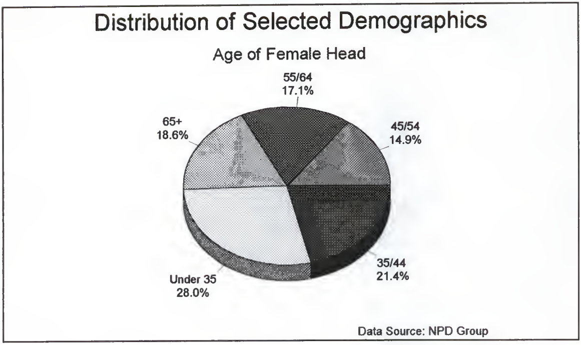


Figure 3.3 Distribution of Selected NPD Demographics: Age of Female Head

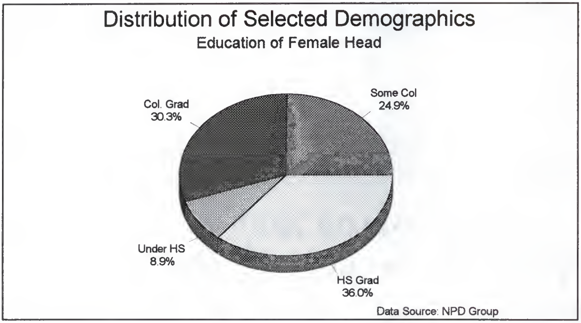


Figure 3.4 Distribution of Selected NPD Demographics: Education of Female Head

Table 3.8 Descriptive Statistics of Demographics Across the NPD Data:1983-93

Demographics	Number of Household(percentage)
All Households	17109 (100%)
HOUSEHOLD SIZE	
1 member	3994 (23.3%)
2 member	5531 (32.3%)
3/4 member	5680 (33.1%)
5+ member	1904 (11.1%)
MARKET SIZE	
1 million	6019 (35.1%)
500/999 m	2418 (14.1%)
250/499 m	2133 (12.4%)
50/249 m	1772 (10.3%)
rural	4767 (27.8%)
EMPLOYMENT OF FEMALE HEAD	
employed	8381 (48.9%)
unemployed	8728 (51.1%)
AGE OF FEMALE HEAD	
<35	4793 (28.0%)
35/44	3655 (21.3%)
45/54	2553 (14.9%)
55/64	2929 (17.1%)
65+	3179 (18.5%)
EDUCATION OF FEMALE HEAD	
no high school	1514 (8.8%)
high school	6155 (35.9%)

Table 3.8 Continued

some college	4252 (24.8%)
college graduate	5188 (30.3%)
CENSUS REGION	
New England	814 (4.7%)
Mid Atlantic	2914 (17.0%)
East North Central	2964 (17.3%)
West North Central	1490 (8.7%)
South Atlantic	2769 (16.1%)
East South Central	1230 (7.1%)
West South Central	1823 (10.6%)
Mountain	1138 (6.6%)
Pacific	1967 (11.4%)
HOUSEHOLD INCOME	
under $19999	6935(40.5%)
20/29999	3367 (19.6%)
30/39999	2440 (14.2%)
40/49999	1865 (10.9%)
50/59999	1112 (6.4%)
60/69999	603 (3.5%)
70/79999	579 (3.3%)
100000+	208 (1.2%)
ADULT FEMALE ON DIET	
yes	11989 (70.1%)
no	5120 (29.9%)

Data Source:NPD Group

percent completly agreed, and 8.7 percent neither disagreed or agreed. Twelve percent disagreed somewhat and mostly. Table 3.9 summarizes the descriptive statistics of attitudinal variables.

The above analysis looks at only attitudinal variations across households, but not attitudinal change over time. Ward(1993) derived a time-series index of consumer concerns about fat, cholesterol, and preservatives over the period of 1984-1993 from the same NPD attitudinal data set that this research utilizes. According to his findings, consumers concerns about those fats and cholesterol were shown to have increased from 1984 to 1990. With the peak in 1990, the upward trend stopped and even was declining slightly. That trend indicates that, throughout the 1980s, consumers concern about health issues were on the rise, but the trend might have reversed direction in the early 90s.

Descriptive Statistics of Dependent Variables

Figures 3.5 and 3.6 show the distribution of per capita servings of five meat categories in a two week period. In the case of beef, 0/6(excluding zero servings) per capita servings hold about 70 percent out of 17109 observations, compared to the less than 40 percent for pork. While the percentage of zero pork servings was unexpectedly high, as much as 66 percent of consumer panels did not serve turkey in a two week period.

Looking at the statistics of household servings, with regard to beef servings, the average serving was the highest as usually found in market disappearance data. The difference between the frequency of beef and other meat consumption was quite distinguishable. Unlike the market data of meat consumption, average consumption frequency of chicken was nearly two times

Table 3.9 Descriptive Statistics of Attitudinal Variables

	Attitudinal Measurements					
Attitudinal Variables	1*	2	3	4	5	6
	Number of Households(Percentage)					
ATDOC**	3697 (21.6)	1714 (10.0)	2637 (15.4)	3689 (21.5)	1237 (7.2)	4135 (24.1)
ATSNK	3644 (21.2)	4083 (23.8)	4665 (27.2)	1613 (9.4)	1837 (10.7)	1267 (7.4)
ATLAB	6998 (40.9)	3460 (20.2)	3042 (17.7)	1493 (8.7)	989 (5.7)	1127 (6.5)
ATWGT	8023 (46.8)	3961 (23.1)	2618 (15.3)	1488 (8.6)	640 (3.7)	379 (2.2)
ATCAL	3482 (20.3)	3433 (20.0)	4668 (27.2)	2417 (14.1)	1756 (10.2)	1353 (7.9)
ATLBS	6904 (40.3)	1382 (8.0)	1682 (9.8)	1079 (6.3)	1322 (7.7)	4740 (27.7)
NTCHL	8400 (49.0)	3839 (22.4)	3315 (19.3)	1143 (6.6)	258 (1.5)	154 (0.9
NTFAT	8725 (50.9)	3926 (22.9)	3062 (17.8)	974 (5.6)	248 (1.4)	174 (1.0)
NTKNO	1231 (7.8)	2339 (14.9)	4469 (28.4)	4688 (29.8)	1884 (11.0)	1093 (6.9)
NTPLN	2447 (15.6)	4490 (28.7)	4995 (31.9)	2215 (14.2)	1085 (6.9)	420 (2.7)

Data Source:NPD Group

* 1=Completely Agree, 2=Agree Mostly, 3=Agree Somewhat, 4=Neither Agree nor Disagree, 5=Disagree Somewhat, and 6=Disagree Mostly.

** See Table 3.1 for the definition of variables.

the frequency of pork consumption. Average consumption frequency of pork showed little difference compared to the frequency of turkey and fish. In the case of beef, the number of zero observations was nonnegligible 16.1 percent, clearly requiring the use of censored models which can provide the explanation of zero servings. With regard to pork, turkey and fish, the number of zero observations was all above 50 percent. Thus, it will be one of the major tasks of this research to find out an appropriate model and provide a good explanation of the occurrence of so many zero servings.

Figure 3.7 shows average annual household servings over the period of 1984-1993. The number of household beef servings drops considerably after 1986. Similar to the pattern of market disappearances data, household servings of chicken and fish rose consistently over the period of 1984-1993.

Table 3.10 Descriptive Statistics of Dependent Variables.

Dependent Variable	Mean	Std Dev	Number of Zero Observations (%)
HOUSEHOLDS CONSUMPTION			
CNBEF	9.09	9.2	2439(16.1%)
CNPOR	1.88	3.2	9862(57.6%)
CNCHK	4.41	5.0	4531(26.4%)
CNTUR	1.60	3.5	11746(68.6%)
CNFSH	1.89	3.0	9208(53.8%)
PER CAPITA CONSUMPTION			
NCNBEF	3.94	3.18	
NCNPOR	0.83	1.20	
NCNCHK	1.68	1.81	
NCNTUR	0.47	1.20	
NCNFSH	0.70	1.19	

Data Source:NPD Group

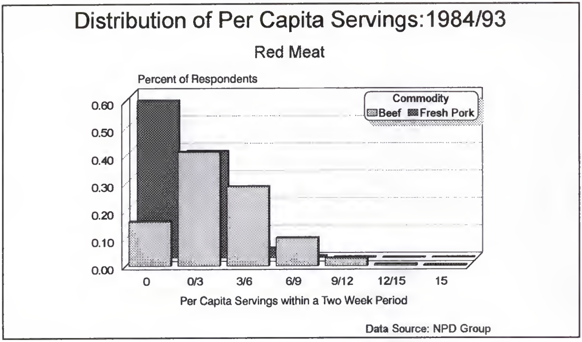


Figure 3.5 Distribution of Per Capita Servings of Fresh Beef and Pork

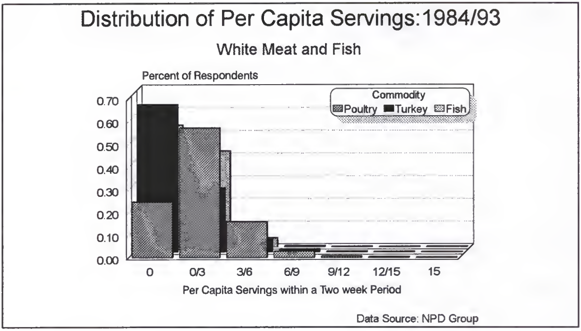


Figure 3.6 Distribution of Per Capita Servings of Fresh Chicken, Turkey, and Fish

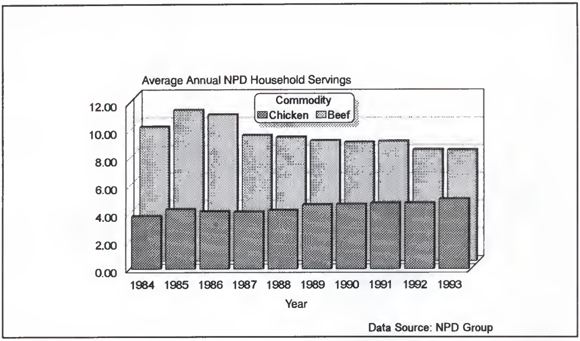


Figure 3.7 Average Annual Household Servings of Fresh Beef and Chicken in a Two Week Period:1984-1993

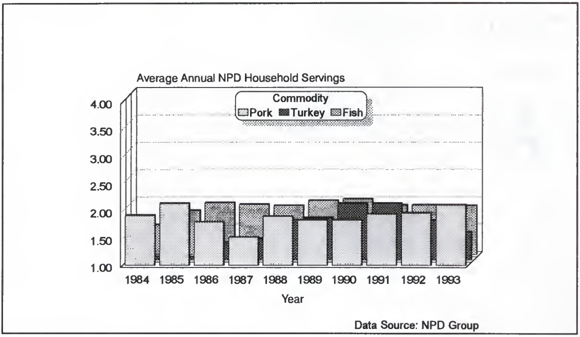


Figure 3.8 Average Annual Household Servings of Fresh Pork, Turkey, and Fish in a Two Week Period:1984-1993

CHAPTER 4
CONCEPTUAL MODEL SPECIFICATION

Overview

Neoclassical demand analysis attempts to explain how individuals make consumption decisions at a given point in time. At a starting point in the theoretical development of consumer demand, one assumes the existence of a finite number of commodities. Nonnegativity, divisibility and unboundedness properties are required to define the commodity set. Then, the existence of a scalar, continuous utility function is assumed over the legally defined commodity set. An implicit assumption in any empirical analysis is that the utility function does not change over the observation period. That is, the neoclassical framework assumes that the underlying preference of consumers and anything else other than prices and income remain constant over the same observation period.

However, no good reason exists not to include deeper analysis of the ceteris paribus assumptions, such as the formation of preference. Some previous efforts have been made. Katona(1951), for example, has pleaded for years for greater interaction between economics and psychology. Consumer behavior, especially, the analysis of the formation and change of preference is a good specific area that can be beneficial from greater interaction between economics and psychology. Hence, in this Chapter we will take a careful look at how psychological concepts within marketing perspectives help us analyze the issues of preference changes. The first section will introduce, as a general background to this study, what consumer behavior is and see how the study of consumer behavior can be used to establish efficient marketing strategies. Then, external(social) and internal(information processing) factors that are significant in shaping consumers behavior will be examined. With this introductory background in consumer behavior, the next section will elaborate the theory of attitude, introduce one of the attitude models, and specify the linkage between attitude and behavior. Finally, conceptual demand model will be developed to link the frequency of meat consumption to the attitudinal evaluations of various meat attributes such as fat, cholesterol, taste or convenience, and to the other economic and demographic variables.

Consumer Behavior in Marketing Perspective

Economic analysis of the effects of prices and income provides fundamental aspects of consumer behavior such as how they spend their funds, how they evaluate alternatives and how they make decisions to maximize their satisfaction. There are still other non-economic factors crucial to the explanation of consumer behavior. Much of the economic analysis has been more concerned with the operation of the economic system than with the behavior of individual buyers. For successful management decision making, firms or industry need detailed information about consumer behavior in addition to analyses of the effects of prices and income on aggregate behavior.

Scholarly interest in consumer behavior coincided with the development of consumer-oriented thinking in business. Analysis of consumer behavior is a basic part of marketing. Marketing identifies the needs and desires of consumers for products and services, provides information for new and improved products and services, informs customers about the many diverse products and services available, determines appropriate prices, and places the products and services where they are needed.

Consumer behavior is defined as the actions and decision processes of individuals and organizations involved in discovering, evaluating, acquiring, consuming and disposing of products and services. Such activities and decision making involve mental and emotional processes, in addition to physical actions. A knowledge of consumer behavior provides the basis for the other marketing functions such as product positioning, market segmentation, pricing, and new product development. Each of these marketing activities is more effective when based on a knowledge of consumer behavior.

In fact, one of the major contributions of the study of consumer behavior to marketing is the identification of meaningful variables upon which to segment markets. Since a market is made up of individuals who vary significantly in terms of education, age, interests, income, occupation, attitude, residence and so forth, it would be close to impossible for the average marketers to design a marketing mix(product, price, promotion, and distribution strategy) with sufficiently universal appeal to influence the purchase decisions of all. Also, many consumers seem to prefer differentiated products, which they feel closely reflect their own personal needs, wishes, personalities, and lifestyles. Consequent strategy that most marketers have developed to handle their vast potential market is to divide it into smaller subgroups or segments, each of which is similar(i.e. homogeneous) regarding some characteristic that is relevant to the purchase or the usage of the product or product category. This process is called market segmenation.

Along with the identification of meaningful variables upon which to segment markets, consumer behavior researchers have put heavy emphasis on the investigation of consumers decision-making processes. By knowing how the individual decision-making process works, and by identifying what components constitute the decision-making process, marketers can come up with appropriate strategies. Specifically, sophisticatedly designed advertising can influence consumers psychological components such as perception, memory or attitudes. The coming section will briefly discuss variables upon which to segment markets, and cognitive factors where advertisement can exert influence and ultimately make change.

Factors That Influence Consumer Behavior

Consumer behavior is influenced largely by individual decision-making processes(internal factors) and social environment(external factors). While all aspects of consumer behavior are important, lots of attention has been devoted to psychological elements of decision-making process. Individual decision-making processes involve such psychological concepts as motive, perception, memory and learning, and attitudes. To introduce the concept of attitude and its roles in consumer behavior, brief discussion of what roles each concept play in consumers decision-making processes will be put forward.

Motivation underlies most behavior. It relates to the needs consumers have as well as the amount of effort directed toward satisfying those needs. Motivation helps explain at the most basic level why consumers seek certain types of purchases. Economics generalizes the motive of consumer behavior as utility maximization. In economics, simply more goods or services generate more utility. Psychologists believe that human behavior is largely goal directed, and consumer behavior is no exception. Thus, asking why someone buys a certain product is another way of asking what the person expects to gain by purchasing it. That is, people are motivated to buy products and services in order to satisfy their needs. These may be basic physiological needs for water, air, food, warmth, sleep, or sex. They may also be social and pschological needs, such as the need for love, friendship, status, self-expression, or a sense of fullfillment.

Perception refers to the process consumers use to recognize, select, organize, and interpret stimuli in ways that make sense of the world around them. Perceptions are affected both by the stimuli themselves and by the perceiver. People are very selective about the types of stimuli to which they expose themselves and the amount of attention they give them. They also are selective about the way they comprehend information and what information they retain. Even if we are surrounded by hundreds of potential stimuli in our perceptual field, we filter out most of these potential stimuli and they never have any impact on our thoughts because we can only interpret a limited number of stimuli at any given time. If somehow we were able to overcome our natural tendency to focus on only a few in order to fully attend to all stimuli, we would experience a chaos of sensations. Fortunately, we are able to attend selectivity to a limited number of stimuli and to organize them into meaningful thoughts. Even when two people attend to the same stimuli, their interpretations are likely to differ, because each person's interpretation distorts the message according to his or her own needs and attitudes.

Memory refers to the storage of information over time. Memory has several components. Sensory memory lasts for a split second; short-term memory lasts for a few seconds; and long-term memory stores information for years. Marketers are interested in what readers remember from an advertisement, what packaging information consumers retain, how much time perspective buyers need to learn particular types of information in communication, and so on.

Learning refers to any change in behavior due to experience. Psychologists have studied in great depth how people learn. While there are a number of schools of thought about how learning works, most researchers agree that learning takes place when we adapt our behavior based on experience. As for what we learn, psychologists think that we learn attitudes, likes and dislikes, most of our motives and needs, and beliefs. As consumers, we learn what products satisfy our needs, what stores carry the merchandise we want, what our family and friends expect us to buy, and a host of other purchase and consumption factors. Learning involves reasoning, classical conditioning, and reinforcement. The cognitive school of learning emphasizes reason and problem; it focuses on knowledge, insights, ideas, attitudes, and goals. According to this approach, brand choice is the result of a clearly defined decision processes, involving complex or simple thinking that depends on the circumstances surrounding the purchase. Consumers develop knowledge that helps simplify the process over time. Classical conditioning was first identified by Ivan Pavlov, whose experiments with a dog, a tuning fork, and meat paste are well known. Conditioning was accomplished by ringing the fork while presenting the meat paste. After conditioning, Pavlov's dog would salivate when only the tuning fork was rung. A similar pattern of association occurs when a brand, such as Mountain Dew soda, is presented along with other stimuli, such as a cool stream on a hot summer day, to elicit a favorable response. Reinforcement learning emphasizes the consequences of action. After a purchase is made, consumers find pleasure or pain based on when others say about the brand, or based on their own evaluation. If the consequence is favorable, it is likely that the purchase will be repeated at some future time.

Finally, attitudes are formed as the result of all the influences introduced so far. They convey both feelings and beliefs about an object. Because attitudes provide insight into relatively complex psychological states, they have been important to consumer behavior research. They determine individuals' preferences. Since the purpose of this research is to provide deeper analysis of preference change which cannot be done adequately by economic framework, the attitudes theory will be used as a conceptual framework. Once we know what an attitude is and how it is linked to behavior, the attitudinal survey data of meat consumption will be ready for use in exploring the preference structure of meat consumption. The nature and properties of attitude will be elaborated in the next section.

As the previous section has shown, the decision-making processes of consumers are affected by characteristics of consumers themselves. Consumers are also influeced by other people. People we see every day as well as those we never see, people who are living now as well as those who went before and helped to shape the culture in which we live-all have an influence on our thought processes. These are social influences that, together with individual characteristics of motivation, perception, memory and learning, and attitudes, affect the consumer's decision-making process. The social factors include personality and life-style, demographics, social class, and culture and subculture.

Psychologists disagree on what the concept of personality encompasses. But it appears from experience that individuals exhibit a consistent pattern of responses to the world. People are frequently categorized or "typed" as having personalities that are aggressive, shy, authoritarian, creative, and so on. Personality is the unique conglomeration of traits that influence how an individual behaves or responds to nearly all situations. Personality traits are unlike opinions and attitudes in that they are more enduring(they tend to stay the same, or to change ever so slowly) and more pervasive(they affect how the person responds to a broad range of objects, whereas attitudes are specific to a particular object. Furthermore, while personality is very specific to the individual, it is not a direct part of the consumer's decision-making process. Therefore, personality must be viewed as an external influence on consumer behavior. Because personality is a set of consistent responses which consumers make in relation to their environment, researchers have sought ways to show how it influences consumer behavior. Ever since Freud hypothesized that personality traits which develop during childhood could explain adult behavior, researchers have been intrigued with the concept. Marketers have used personality to show how consumers are likely to select particular brands. Personality is not part of information processing because it is not likely to change with regard to a particular purchase. The individual's personality will probably remain constant; and although it may influence specific thoughts, it should not be considered part of the thought process. However, personality can give us important insight into another behavioral element: life-style.

Life-styles refers to a consumer's distinctive mode of living, including how money and time are spent on activities that occupy important portions of a person's life. For example, some consumers are particularly interested in cooking or politics, while others focus on physical fitness and nutrition. Life-style has become a catch-all word for how people live, particularly in terms of their interests, activities, and opinions regarding a broad range of subjects. Whereas, demographic data tend to describe people in quantitative terms, psychographic data add a qualitative dimension by describing consumers according to how they function in society and particularly the situations in which they use various products. Recently, consumer behavior researchers have begun to study the influence of life-style on purchasing decisions. This type of research is called psychographics. Psychographic research involves the study of consumer activities, interests, and opinions. Thus life-style data on consumers reflect their work, use of leisure time for recreation or travel, their interests, such as job, family, sports, the opposite sex, or public affairs, and their opinions about family, politics, environmental quality, and a host of other issues.

In order to better understand consumer behavior, researchers classify consumers according to the characteristic or behaviors they exhibit. The oldest approach to this classification is based on demographic data. Demographics include age, gender, income, stage in the life cycle, and geographic location. These characteristics of the individual or household influence purchase behavior. Although they are not subject to influence or change by marketers, it is useful for marketers to have demographic information when developing marketing programs.

Social class encompasses the distinction between groups within a culture based on such aspects as occupation, income, and education. The concept of class implies that there are homogeneous groups that are relatively permanent. While a person's occupation may change, that person will probably remain in or near the social class associated with his or her former occupation, parents' occupation, type of education, and so on. A clear understanding of the values and motivations within a particular class is , of course, useful to a marketer hoping to target that class effectively.

A culture includes more than just the aggregation of people in a social system. It encompasses the values, mores, customs, folkways, and norms that are shared by those making up the social system. In addition, these shared values and norms are transmitted from generation to generation, within the social system, so there is a strong link between culture and learning. All of us are products of our culture to some extent. The process by which we learn the patterns of a certain culture is called socialization when we are reared in that culture, and acculturation when we enter that culture later in life. Whereas the family unit is the principal instrument by which culture is transmitted, socialization is really a responsibility of the entire social system, including the educational, political, and legal subsystems called institutions.

At a very broad level, we can refer to our values as common to "the western world", meaning most of Europe, Australia, and North and South America. Because people in these continents are descendants of Europeans who treasured their Greco-Roman and Judeo-Christian heritages, they share many values, mores, customs, folkways, and norms which differentiate them from the cultures of the East. At a lower level, the cultural distinction can be based on nations. Also, within a culture such as that of the U.S., there are a number of subcultures. Among them are Blacks, Latinos, American Indians, American Jews, Asians and others. Thus, what is important to marketers is to recognize differences between the value systems of America's subcultures.

The Nature Of Attitude

Attitudes are an expression of inner feelings that reflect whether a person is favorably or unfavorably predisposed to some object. As an outcome of some psychological process, attitudes are not directly observable but must be inferred from what people say or from their behavior. Thus, consumer researchers tend to assess attitudes by asking questions or inferring attitudes from behavior. To illustrate, if a researcher determines from questioning a consumer that the individual has consistently bought Close-Up toothpaste and recommends it to friends, the researcher would be likely to infer a positive attitude toward Close-Up.

This illustration suggests that a whole universe of consumer behavior - consistent purchase, recommendations to others, top rankings, beliefs, evaluations, and intentions - are related to attitudes. Now, defining an attitude seems to be in order. An attitude is a learned predisposition to respond in a consistently favorable or unfavorable manner with respect to a given object. The word "object" in this definition of attitude is designed to be substituted by specific concepts such as issues, actions, behavior, practices, persons or events. It can be product category, brand, price, advertisement, or the quality of services in consumer behavior.

There is general agreement that attitudes are learned. This means that attitudes relevant to purchase behavior are formed as an outgrowth of direct experience with the product, and/or the information acquired from others and exposure to mass media. Therefore, while attitudes are relatively enduring, their changes are possible. Another characteristic of an attitude is that it is relatively consistent with the behavior that it reflects. When consumers are free to act as they desire, it is anticipated that their actions will be consistent with their attitudes. However, circumstances are not always uniform. Therefore, situations might cause consumers to behave in a manner seemingly inconsistent with their attitudes. In fact, a number of studies have reported that consumer attitudes may vary from situation to situation.

Traditional models viewed attitude as consisting of three components: cognitive component, affective component, and conative component. The cognitive component refers to the knowledge, beliefs, and opinions the person has about the attitude object. The affective component reflects feelings, evaluations, or emotions regarding the attitude object. The conative component reflects behavioral tendencies toward the attitude object(conation refers to the act of attempting something). During the last 20 years, however, consumer researchers have shifted their emphasis away from the three-component view toward a more singular view of "attitude as affect". This shift does not discount the importance of the other two components. It simply proposes an ordered relationship among the three sectors. The following figures depict the two views. While Figure 4.1 describes that attitudes are influenced from all of the three component, in Figure 4.2, affect(attitude) is seen as being built upon beliefs, but intentions depend on both the beliefs and attitude. When modern consumer researchers speak of attitudes, they are referring to the affective component - the liking or disliking of specific products, people, brands, or stores. Generally, in the literature the traditional classification is called tricomponent model and the recent model as a single-component attitude model.

Consumers form and maintain their attitudes because attitudes are useful to them. Attitudes serve four major functions: Knowledge, Ego-defense, Value-expression, and Adjustment. The knowledge function of attitudes governs consumer's selective perception process, and helps partially to explain consumer's resistance to persuasion from unknown or disliked marketers. Another function that attitudes sometimes serve involves protecting consumer egos from threats to their self-identities and feelings of personal worth. Within marketing, ego-defense attitudes are likely to be operating for some consumers in such areas as sex appeal or social attractiveness. In contrast to the reactive nature of the ego-defensive function, the value-expressive function of attitudes represents a more positive approach of a consumer to his or her environment. In these cases

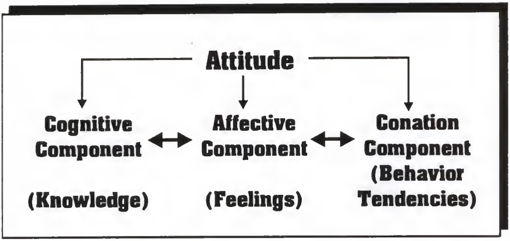


Figure 4.1 Traditional View: Three Component

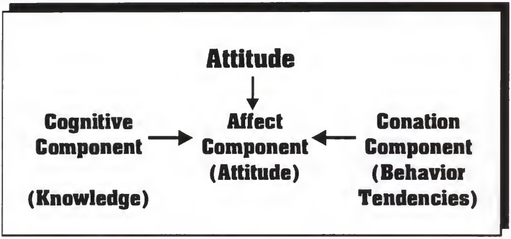

Attitude
Cognitive Component
(Knowledge)
Affect Component (Attitude)
Conation Component (Behavior Tendencies)

Figure 4.2 The Recent View: A Stress on Affect

consumer attitudes allow strongly held personal values to be expressed in consumer behavior. Adjustment serves the purpose of helping us intelligently to adjust our likes and dislikes to the realities of our external environment. Thus the adjustment function is utilitarian in nature - it helps consumers to maximize their pleasure and minimize their pain as they deal with their environment and decision chains.

Meanwhile, attitude researchers need to measure attitude in some way to utilize it in predicting consumer behavior accurately. The attitudinal survey data of meat servings that are going to be employed in this research have been measured according to Likert scales. Likert scales can be recognized by their characteristic "agreement" scale, which provides respondents with the opportunity to reveal their degree of agreement or disagreement with a series of statements that are prepared to fully describe their attitudes about issues and concerns.

Multiattributes Model

The single-component attitude model is popular with marketing researchers who want to save time and space by including a large evaluative scale on a questionnaire. However, although it is uncomplicated, the single-component model fails to provide useful insights as to what influences or explains a consumer's evaluative rating. To illustrate, two consumers may possess the same positive attitude(i.e., the same level of affect) toward, say, Aqua-fresh tooth paste with quite different salient beliefs: that is, one may like it because of its fresh taste, whereas the other may like it because it helps whiten teeth. Unless the researchers were to measure each consumer's beliefs and evaluation about each attribute of Aqua-fresh, all that would be known is that they possess the same basic level of affect toward Aqua-fresh. Thus, we would be left in the dark as to the underlying knowledge and beliefs that the consumers are likely to bring to bear in arriving at their overall assessment.

To overcome the shortcomings of the single-component attitude model, a multiattribute model has been proposed(Fishbein, 1967). Basically, a multiattribute model views an attitude object as possessing many attributes(characteristics) that provide the basis on which consumer's attitude depend. While there are many variations of this type of attitude model, the attitude-toward-object model, originally proposed by Fishbein, will be introduced here. The Fishbein attitude-toward-object model is usually depicted in the form of the following equation.

$$Attitude_0 = \sum_{i=1}^{n} B_i E_i \tag{4-1}$$

Where, Attitude_0 = attitude toward the object

B_i = the importance of the attribute i

E_i = the evaluation of attribute i

N = the number of attributes about the object

In this model, overall attitude toward an object is a function of two factors: the importance of the attributes associated with the object and the evaluations of those beliefs. The evaluations of each attribute(E_i) reflects how favorably the consumer perceives that attribute. In marketing studies, both the importance and evaluation are obtained through consumer surveys, and then overall attitude toward an object can be calculated from them.

The main idea in the multiattribute model is that the evaluations of attributes cause overall attitude. Simply stated, people tend to like objects they associate with "good" characteristics and dislike objects they believe to have "bad" ones. Fishbein argued that the typical number of attributes about an attitude is not likely to exceed seven to nine. He also maintained that, given consumer's limited capacities for interpreting and integrating information, even fewer attributes for many objects are expected. The evaluation of each attribute(E_i) is sometimes called miniattitude because it represents attitude only toward the attributes of the product not toward the product itself.

Conceptual Model Specification

We have seen that overall attitude is comprised of the multiplication of miniattitudes(E_i) and the importance of attributes (B_i). Assuming that the importance of the each attribute is constant, overall attitude depends only on miniattitude. That is, overall attitude and evaluation of each attribute can have certain functional relationships. Converting equation 4-1 into general form

$$\text{(4-2)} \qquad \textit{Overall Attitude} = f\,(\textit{ Miniattitudes})$$

Now we need to relate attitude to behavior to specify a conceptual demand model in which consumption frequency of various meats will be linked to economic, socio-demographic variables, and attitudinal reponses of consumers about health-related attributes of beef, pork, chicken, turkey and fish. There has been considerable controversy in consumer behavior literature about the linkage between attitude and behavior. Despite that, theoretically, attitudes should be consistent with behavior, considerable researches have found out inconsistencies between attitude and behavior. To explain the inconsistencies, consumer behavior researchers introduced intervening variables. Among those variables are the variable of 'intent to act' which predict behavior much better than attitudes, and 'situational variables'. Basically, the relationship between attitude and behavior should be consistent as long as the situations are the same although the strength of the relationship may differ case by case. Expressing it as a function

$$(4\text{-}3) \qquad \mathit{Behavior} = f(\mathit{Overall\ Attitude} : \mathit{External\ Conditions\ Remain\ Constant})$$

Here, external conditions imply economic, socio-demographic variables and other consumers(respondents) characteristics. Substituting (4-2) into (4-3)

$$(4\text{-}4) \qquad \mathit{Behavior} = f(\ \mathit{Miniattitudes} : \mathit{Ceteris\ Paribus})$$

If we have observations on both sides, this is a function that is empirically estimable, thereby measuring the strength of the impact or importance of each attribute on the occurrence of the behavior. Unlike marketing studies, we are measuring statistically the importance of each attribute.

Since the main purpose of this research was to determine if variables in regard to health and nutrition, and convenience were significant in consumers' meat servings decisions, such attributes as fat, cholesterol, calorie, taste, freshness and convenience were presumed to be the attributes of beef, pork, chicken, turkey, fish and other meats. Then, from equation (4-4), behavior is equivalent to the frequency of the meat servings, and miniattitudes to attitudinal responses of consumers about the above cited attributes of meat. In addition, indexes of eating behavior, which were derived in Chapter 2 and composed of FDHOT, FDPIZ, FDLUN,FDTAC, AND FDFCH, are possible explanatory variables. Specifying in detail

$$\begin{aligned}(4\text{-}5) \qquad &\mathit{Frequency\ of\ Meat\ Servings} = f\ (\ \mathit{Attitudes\ toward\ Fat,\ Cholesterol,\ Freshness,} \\ &\mathit{Calorie,\ Taste,\ Convenience,\ Indexes\ of\ Eating\ Behavior} : \mathit{Ceteris\ Paribus})\end{aligned}$$

Cross-sectional observations on both sides make it possible to statistically estimate and measure the strength of the impact of health-related and convenience variables on the frequency of meat servings. Equation (4-5) specifies the model to analyze preference structure for meat. Now adding external variables to the model completes the conceptual model for this research.

(4-6) *Frequency of Meat Servings = f(Economic, Socio-Demographic Variables,*
Indexes of Health Concerns, Indexes of Eating Behavior,
Other Psychological Characteristics)

Economic variables include prices, income, and beef checkoff expenditures. Socio-demographic characteristics included in this research are Household Size(DMHSZ), Market Size(DMMSZ), Employment status of Female Head(DMFEM), Age of Female Head(DMAGE), Education of Female Head(DMEDU), Census Region(DMREG), and Household Income(DMINC). Other psychological characteristics relevant in this research involve those questions: Doctors give advice on diet(ATDOC), Important to eat regular meals(ATREG), Conscious of calories(ATCAL), Know more about nutrition than others(NTKNO), Plan nutritious meals(NTPLN), and Most important food looks, smells, tastes good(NTLOK).

CHAPTER 5
ECONOMETRIC CONSIDERATIONS

Introduction

In the previous chapter, the frequencies of servings(0, 1, 2,...) in two weeks of beef, pork, chicken, turkey, and fish were hypothesized to be dependent on attitudes toward products attributes, demographic profiles, and economic variables. Accordingly, the demand models for this research have zero or positive values as dependent variables. The frequencies as dependent variables raise two major estimation problems.

Since the dependent variables are censored at zero, a range of values of the variable of interest introduces a distortion into conventional statistical results. When the dependent variable is censored, values in a certain range are all transformed to a single value.

The second problem is a matter of behavioral assumptions, that is, the kind of assumptions we make about consumer decision making processes. Frequency data contains both zero and positive values. The decisions to consume or not and then intensity of consumption may be ruled by two different probablity distributions and different sets of explanatory variables. The probability of a household participating in the market is directly modeled in a probit equation, and simultaneously estimated with a consumption equation. Even when the same set of independent variables are included in the two equations, the estimated parameters can differ between the two types of decisions. In a cigarette consumption study, Jones(1989) established a behavioral foundation for the two-step decision making process by exploiting the observation that there might be certain characteristics of smoking which relate directly to the qualitative distinction between 'smokers' and 'non-smokers' and which are independent of the quantity consumed. Similar logic can be applied to meat consumption, although it remains to be tested against a one-way decision making process. That is, health concerns which are assumed to be one of the most salient characteristic of meat consuming behavior might distinguish meat consumers qualitatively from non-meat consumers. Let alone health concerns, there can be other variables that have strong effect on the participation equation but have little effect on the consumption level.

In a slightly different way, goods purchased at infrequent intervals can be modeled with a two-equation purchase-infrequency model, another extention of original Cragg's double-hurdle model. In the purchase-infrequency specification, a probit equation represents the probability of observing a purchase over the survey period. Then, consumption or expenditure equation is conditional on that a purchase is observed.

Tobit model does not differentiate the two decisions in the sense that the same probability distribution and same set of explanatory variables govern the two-step decision making processes and does not account for the possibility of observing zero expenditures over the survey period because of an infrequent purchase cycle. Tobit and Cragg's double-hurdle model will be introduced in the second and third section of this chapter. Then, after purchase-infrequency model is outlined in the fourth section, a generalized likelihood function which nests all of the three models will be developed to illustrate how the three models are related. The last section examines several ways of conducting specification tests for the selections among Tobit, double-hurdle, and other nonnested models.

Tobit Model

The Tobit models were developed in order to effectively handle censored data and get better performance of the estimators. Data for which values of the dependent variable, corresponding to a known set of explanatory variables, can only be observed for a limited range are said to be censored. There is usually a significant portion of zero reports of consumption or expenditures in household surveys in a given period. It might be because utility maximizing amount of expenditures for some households is less than the unit price of the commodity in question. It will be clearer when the commodity is a durable good. Then, instead of observing the utility maximizing amount of expenditures, zero observations can also occur. In that sense, the consumption or expenditure data are censored at zero. Supposing that the utility maximizing amount of expenditures on a good, y^*, a latent variable, is taken to be explained by the model

$$(5\text{-}1) \qquad y_i^* = x_i'\beta + e_i \qquad i = 1...N$$

where e_i are residuals that are independently and normally distributed, with a mean zero and a common variance σ^2. The problem for a household is that there is some minimum level of expenditures required to purchase a durable good, c. Thus for any household, the amount of expenditures actually observed(y) is

$$(5\text{-}2) \qquad \begin{aligned} y_i &= y_i^* && \textit{if} \quad y_i^* > c \\ &\; 0 \textit{ or } c && \textit{if} \quad y_i^* \le c \end{aligned}$$

Thus, the observed amount of expenditure may be the desired level or it may be 0 or c, which simply reflects that $y^* < c$. Combining equations (5-1) and

(5-2)

$$y_i = X_i'\beta + e_i \qquad if \quad X_i'\beta + e_i > 0 \tag{5-3}$$
$$= 0 \qquad otherwise$$

Equation (5-3) is the standard form of Tobit or censored regression model.

The above discussion of utility maximizing behavior gives a reasonable explanation of the existence of zero observations and censoring in survey data. To see the statistical problems caused by this censoring and zero observations, suppose that we perform a regression analysis only based on the positive observation of y_i. Writing out the expectation of the observed values of y_i conditional on the fact that $y_i > 0$

$$E[y_i \mid y_i > 0] = X_i'\beta + E[e_i \mid y_i > 0] \tag{5-4}$$
$$= x_i\beta + \sigma f/F_i$$

If the conditional expectation of the error term is 0, there is no problem, because a least squares regression on the positive observations will provide an unbiased estimator. But this is not the case, since, if the e_i are independent and normally distributed random variables, then(Judge et.al, 1988)

$$E[e_i \mid y_i > 0] = E[e_i \mid e_i > -X_i'\beta] = \sigma f/F_i > 0 \tag{5-5}$$

It can also be shown that applying OLS to all observations would not lead to a consistent estimator of the population regression function, since unconditional expectation of y_i is

$$(5\text{-}6) \qquad E[\,y_i\,] = F_i * (X_i'\beta) + \sigma * f_i$$

$$= F_i * E[y_i | y_i > 0]$$

Here, F_i stands for cumulative distribution function and f_i for standard density function evaluated at $X_i\beta/\sigma$(see Green for detailed derivation of the equation). Therefore, to obtain consistent estimator, a different method of estimation is required.

Amemiya(1973) has proven that maximum likelihood procedures applied to the Tobit model give strongly consistent and asymptotically normal estimator. Likelihood function of the sample censored at zero has a component for the observations that are positive and one for those that are 0. For observations that y_i is equal to 0, it was previously shown that $X_i\beta + e_i < 0$, then

$$(5\text{-}7) \qquad Pr[\,y_i = 0] = Pr[e_i < -x_i'\beta]$$

$$= Pr[e_i/\sigma < -x_i'\beta/\sigma]$$

$$= 1 - F_i$$

For observation y_i that are greater than zero, we have

$$(5\text{-}8) \qquad Pr[y_i > 0] * f[\,y_i \mid y_i > 0] = Pr[e_i > -x_i\beta/\sigma] f(y_i - x_i\beta,\ \sigma^2)/Pr[e_i > -x_i\beta]$$

$$= F_i * f_i(y_i - x_i'\beta,\ \sigma^2)/F_i$$

$$= f_i(y_i - x_i'\beta,\ \sigma^2)$$

$$= \frac{1}{\sqrt{2\pi\sigma^2}}\ EXP\ -(\frac{1}{2\sigma^2})\ (y_i - x_i\beta)$$

Hence, the likelihood function for the full sample is

$$(5\text{-}9) \qquad L = \prod\nolimits_0 (1 - F_t) \prod\nolimits_1 \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{1}{2\sigma^2}(y_t - x_t'\beta)^2}$$

Here, the first product is over the observations for which $y_i = 0$ and the second product is over the observations for which $y_i > 0$. Then, the log likelihood function to be maximized is

$$(5\text{-}10) \qquad \ln L = \sum\nolimits_0 \ln[1 - F_t] + \sum\nolimits_1 \ln(\frac{1}{\sqrt{2\pi\sigma^2}}) - \sum\nolimits_1 \frac{1}{2\sigma^2}(y_t - x_t\beta)^2$$

Olsen(1976) proved that the the Tobit likelihood function is globally concave, that is, has a single maximum. The following can be used to derive the first and second derivatives of log likelihood function with respect β and σ^2.

$$\frac{\partial F_t}{\partial\beta} = f_t X_t$$

$$\frac{\partial F_t}{\partial\sigma^2} = -\frac{1}{2\sigma^2}\beta' X_t f_t$$

$$\frac{\partial f_t}{\partial\beta} = -\frac{1}{\sigma^2}\beta' X_t f_t X_t$$

$$\frac{\partial f_t}{\partial\sigma^2} = \frac{(\beta' X_t)^2 - \sigma^2}{2\sigma^4} f_t$$

The first order conditions for a maximum are given by

$$(5\text{-}11) \qquad \frac{\partial \ln L}{\partial\beta} = -\sum\nolimits_0 \frac{f_t X_t}{1 - F_t} + \frac{1}{\sigma^2}\sum\nolimits_1 (y_t - x_t'\beta)x_t = 0$$

$$(5-12) \qquad \frac{\partial \ln L}{\partial \sigma^2} = \frac{1}{2\sigma^2}\sum\nolimits_0 \frac{x_i'\beta f_i}{1-F_i} - \sum\nolimits_1 \frac{1}{2\sigma_2} + \frac{1}{2\sigma^4}\sum\nolimits_1 (y_i - x_i'\beta)^2 = 0$$

Solving equations (5-11) and (5-12) for the parameters involves highly nonlinear computations, and it is not possible to derive analytical expression for the nonlinear maximum likelihood estimator. Instead, iterative numerical methods must be used to obtain estimates. Three computational algorithms are commonly used to obtain maximum likelihood estimates: the method of scoring, the Newton-Raphon and an algorithm usually attributed to Berndt, Hall, Hall and Hausman(BHHH)(Judge et. al., 1988). The Newton-Raphson method uses the inverse of the Hessian matrix, which requires second derivatives of the log likelihood function, whereas the method of scoring uses of the inverse of the expectation of the Hessian matrix, or, in order words, the negative of the inverse of the information matrix. The BHHH algorithm uses product of first derivatives in the place of the Hessian matrix. A general expression for all three algorithms is

$$5-13) \qquad \beta_{n+1} = \beta_n - P_n \frac{\partial L}{\partial \beta}\Big|_{\beta_n}$$

$$\textit{where} \qquad P_n = \left[\frac{\partial^2 L}{\partial\beta\partial\beta'}\right]^{-1}\Big|_{\beta_n} \qquad \textit{for the Newton Raphson algorithm}$$

$$P_n = \left[E\frac{\partial^2 L}{\partial\beta\partial\beta'}\right]^{-1}\Big|_{\beta_n} \qquad \textit{for the method of scoring}$$

$$= -\left[\sum\nolimits_{t=1}^{T}\left(\frac{\partial L_t}{\partial\beta}\right)\left(\frac{\partial L_t}{\partial\beta'}\right)\right]^{-1}\Big|_{\beta_n} \qquad \textit{for the BHHH algorithm}$$

The iteration continues until convergence occurs, that is, β_{n+1} becomes β.

Asymptotic covariance matrix for β's for each algorithm can be found from

$$(5\text{-}14) \qquad cov(\beta) = -[\frac{\partial^2 L}{\partial\beta\,\partial\beta'}]^{-1}|_{\beta,\,\sigma^2} = 2\,\sigma^2[\frac{\partial^2 S}{\partial\beta\partial\beta'}]^{-1}|_{\beta} \quad \textit{for Newton-Rapson algorithm}$$

$$\textit{where} \quad S = (Y - f(X,\ \beta))'(Y - f(X,\ \beta))$$

$$= -[E\frac{\partial^2 L}{\partial\beta\partial\beta'}]^{-1}|_{\beta,\,\sigma^2} = \sigma^2[Z(\beta)'Z(\beta)]^{-1} \quad \textit{for the method of scoring}$$

$$\textit{where,} \quad Z(\beta) = \frac{\partial f(X,\ \beta)}{\partial\beta}$$

$$= [\textstyle\sum_{t=1}^{T}(\frac{\partial L_t}{\partial\beta})(\frac{\partial L_t}{\partial\beta})]^{-1}\ |_{\beta,\sigma^2} \quad \textit{for the BHHH algorithm}$$

Square roots of the diagonal elements of the asymptotic var-cov(B) matrix are the asymptotic standard errors for the parameter estimates.

Marginal Effects and Decomposition of the Tobit Model

The maximum likelihood estimates derived in the previous section do not alone indicate the effects of a change in explanatory variables on dependent variable because the unconditional expected value E(y) in equation (5-6) is no longer equal to $X_i\beta$, a property of OLS. Calculation of the marginal effects of explanatory variable on the dependent variable is necessary for the purposes of prediction or simulation. There are three ways of calculating the marginal effects depending on what equation we use among the following three

$$E(y_i^*) = x_i\beta,$$

$$E(y_i|y_i^*>0) = x_i\beta + \sigma f_i/F_i,$$

$$E(y_i) = F_i*x_i\beta + \sigma*f_i = F_i*E(y_i|y_i^*>0)$$

The first one is based on the equation (5-1) with the additional assumption of $E(e_i)=0$. The second equation gives the expectation of the observed values of y_i conditional on the fact that y_i is greater than zero. The third one is based on the equation of (5-6). What this equation gives is the mean of all observed y's , positive and zero.

The corresponding marginal effects of the above three equations are respectively

$$\text{(5-15)} \qquad \partial E(y_i^*)/\partial x_j = \beta_j$$

$$\partial E(y_i|y_i^*>0)/\partial x_j = \beta_j(1 - \sigma f_j/F_j - f_j^2/F_j^2)$$

$$\begin{aligned}\partial E(y_i)/\partial x_j &= F(x_j\beta)*\partial E(y_i|y_i^*>0)/\partial x_j \\ &\quad + E(y_i|y_i^* >0)*\partial F(x_j\beta)/\partial x_j \\ &= \beta_j(1 - \sigma f_j/F_j - f_j^2/F_j^2)*F(x_j\beta) \\ &\quad + E(y_i|y_i^*>0)f_j\beta_j/\sigma \\ &= \beta_j*F(x_i\beta)\end{aligned}$$

The above adjustments in the Tobit regression coefficients required to compute the marginal effect of a change in the ith variable of X on unconditional Y was originally suggested by McDonald and Moffitt(1980). The adjustments decomposes the Tobit estimates into two component: 1)the change in Y of those of above the limit, weighted by the probability of being above the limit; and 2)the change in the probability of being above the limit, weighted by the expected value of Y if above. This decomposition gives useful insights in distingushing the effect of explanatory variable on the positive observation from the effect on probability of observing above zero values.

However, the decomposition is still based on the one set of estimated Tobit results. In the next section, the double-hurdle model rigorously decomposes the two effects based on two different sets of parameters representing the two effects of explanatory variables on the magnitudes of positive observations and on the probability of being positive.

Double-hurdle Model

When we have some zero observations in the sample, it is tempting to use the Tobit model. Equation (5-3) is a situation where y* can, in principle, take on negative values, but we do not observe them because of censoring. Due to nonobservability of negative values, zero values are observed. However, dependent variables such as expenditures on durable goods, hours worked, or wages can not assume negative values. Maddala(1992) insists that, in a strict sense, the observed zero values are due not to censoring, but due to the decisions of individuals. Therefore, he suggests that a procedure is needed to model the decisions that produce the zero observations rather than use the Tobit model mechanically. A double-hurdle model is one of several ways of modelling the behavior generating zero observations.

The Tobit model assumes that the decision on whether to consume, $Pr(y_i = 0)$, and on how much to consume, $Pr(y_i > 0) * f(y_i \mid y_i > 0)$ are based on the same stochastic process(the same variables and parameter). Consequently zero observations on consumption always imply that the desired or optimal level of consumption, determined via the utility maximization process, is non-positive. Several studies, however, have recognized other possible explanations for zero observations on the dependent variable. Among them, Cragg(1971) has modeled a situation in which the consumer desires a positive amount of the good in question, but consuming the good depends not only on the intensity of that desire but also on such factors as search, information and transaction costs. That is, according to Cragg, zero observations may arise either because the desired change is not positive or because other factors inhibit carrying out changes which would be desired in their absence. In other words, it is possible that, while a consumer desires a positive amount, no consumption occurs when the barriers to consuming are high enough to prohibit consumption from taking place.

This extended interpretation of zero observations led to the modelling of consumption behavior in two stages: first, based on the barriers to consumption, the consumer determines whether to consume the good or not, and second, in accordance with the intensity of the desire for the good, the consumer decides on how much to consume. Blundell and Meghir(1987) have labeled the model 'bivariate' meaning that there are two separate processes determining the zero-one discrete behavior and determining the quantity of the positive observations. Allowing these separate processes relaxes one of the strong assumptions underlying the standard Tobit model.

Restrictiveness of the Tobit model is well documented in the hypothetical example of buildings given by Lin and Schmidt(1983), in which the dependent variable analyzed is "loss due to fire" during some time period. Since this is often zero but otherwise positive, the Tobit model might be an obvious choice. However, they suggest that it is not hard to imagine that newer(and more valuable) buildings might be less likely to have fires, but might have greater average losses when a fire did occur. Since, in the Tobit model, any explanatory variable(in this case, age of building) which increases the possibility of a non-zero value must also increase the mean of the positive values, the Tobit model can not accommodate this possibility. That is, in the Tobit model, the age of building should increase the probability of the occurrence of fire and the amount of the loss due to fire. Double-hurdle models allow the independent variable, age of building, to have positive effect on the probability of the occurrence of fire but to have negative effect on the amount of loss due to fire.

The double-hurdle or bivariate model is represented as

$$\text{(5-16)} \qquad \begin{aligned} y_i &= y_i^* && \textit{if} \quad y_i^* > 0 \quad \textit{and} \quad D_i > 0 \\ &= 0 && \textit{otherwise} \end{aligned}$$

$$y_i^* = x_i'\beta + e_i$$

$$D_i = z_i\theta + v_i$$

Here, y_i is actually observed consumption, and y^* being utility maximizing amount of consumption. D_i characterizes the zero-one discrete decision of whether to participate in the market or not(whether to consume or not). X_i is a vector of explanatory variables determining the quantity of the positive observations, while Z_i is a vector of variables explaining the zero-one decision. The vectors of independent variables(X_i, Z_i) need not be different, and the error terms(e_i, v_i) are assumed to be independently normally distributed with zero means and constant variances.[5]

The model shows that, to observe a positive dependent variable, two hurdles($y^* > 0$ and $D_i > 0$) must be overcome. First, a positive amount has to be desired. Second, favorable circumstances have to arise for the positive desire to be carried out. Then, the probability of a zero observation in the double-hurdle model is

$$
\begin{aligned}
(5\text{-}17) \qquad Pr(y_i = 0) &= Pr(y_i^* < 0) + Pr(y_i^* > 0)Pr(D_i < 0) \\
&= 1 - Pr(y_i^* > 0)Pr(D_i > 0) \\
&= 1 - Pr(e > -x_i\beta)Pr(v > -z_i\theta) \\
&= 1 - F(x_i\beta/\sigma)F(z_i\theta)
\end{aligned}
$$

The first term of the right-hand side of the first line, $Pr(y^* < 0)$, implies that optimal solution of utility maximizing process is non-positive. The second term, $Pr(y^* > 0)Pr(D_i < 0)$, represents that we observe zero values on the dependent variable because the barriers to consuming inhibit consumption from taking place, while positive amount is desired. Thus, in the double-hurdle model the probability of a zero is a sum of the two cases. The Tobit model does not have the second term. For observations greater than zero, we have

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[5] Dependent double-hurdle model, where the error terms are correlated, will be shown later.

$$(5\text{-}18) \qquad \begin{aligned} Pr(y_i > 0)f(y_i \mid y_i^* > 0) &= Pr(D_i > 0)Pr(y_i^* > 0)f(y_i \mid y_i^* > 0) \\ &= Pr(v > -z_i\theta)Pr(e > -x_i\beta)f(y_i \mid y_i^* > 0) \\ &= F(x_i\beta/\sigma)F(z_i\theta/\sigma)f(y_i - x_i\beta,\ \sigma^2)/F(x_i\beta/\sigma) \\ &= F(z_i\theta/\sigma)f(y_i - x_i\beta,\ \sigma^2) \end{aligned}$$

Consequently, the sample log-likelihood function takes the form

$$(5\text{-}19) \qquad \begin{aligned} \ln L &= \textstyle\sum_0 \ln(1 - F(x_i\beta/\sigma)F(z_i\theta)) + \sum_1 \ln F(z_i\theta) \\ &\quad + \textstyle\sum_1 \ln\dfrac{1}{\sqrt{2\pi\sigma^2}} - \sum_1 \dfrac{1}{2\sigma^2}(y_i - x_i\beta)^2 \end{aligned}$$

Again, zero expenditures can either indicate that it is a optimal solution of utility maximization process or that the household does not consume the product because of other factors inhibiting carrying out the consumption. If $F(z_i\theta)$ is equal to 1, that is, every household participate in the market, equation (5-19) reduces to the Tobit specification.

Cragg suggested a slightly simplified version of (5-19) in the same paper in which the position of previous two hurdles is reversed. The model will be referred to as Cragg's second double-hurdle model. In this case a decision has to be made about whether to consider a change or not. Then a decision on the amount of the change is taken. Cragg noted that the first decision can be represented by a probit model; the second, by a standard regression model. Hereafter, we will force the two decisions to have the same set of explanatory variables making $X_i = Z_i$, but still allow them to have differential impact on the two decisions. Note that we do not have sound theoretical discretion to include certain variables in one equation but not in the other equation. The probability of a zero observation in this simplified second double-hurdle model is

$$(5\text{-}20) \qquad \begin{aligned} Pr[y_t = 0] &= Pr[D_t < 0] \\ &= 1 - F(x_t\theta) \end{aligned}$$

With regard to positive observations

$$(5\text{-}21) \qquad \begin{aligned} Pr[y_t > 0]f(y_t \mid y_t^* > 0) &= Pr[D_t > 0]f(y_t \mid y_t^* > 0) \\ &= Pr[v > -x_t\theta]f(y_t - x_t\beta,\ \sigma^2)/Pr[e > -x_t\beta) \\ &= F(x_t\theta)f(y_t - x_t\beta,\ \sigma^2)/F(x_t\beta/\sigma) \end{aligned}$$

Then, the log likelihood function of the simplified double-hurdle model becomes

$$(5\text{-}22) \qquad \begin{aligned} \ln L = \textstyle\sum_0[1 - F(x_t\theta)] + \sum_1 \ln \frac{1}{\sqrt{2\pi\sigma^2}} - \sum_1 \frac{1}{2\sigma^2}(y_t - x_t\beta)^2 \\ + \textstyle\sum_1[\ln F(x_t\theta) - \ln F(x_t\beta/\sigma))] \end{aligned}$$

If $\theta = \beta/\sigma$, this likelihood function is the same as the one of the Tobit specification. Thus, the likelihood function of Tobit is also a special case of second double-hurdle model. First derivatives corresponding to the equation (5-22) are

$$(5\text{-}23) \qquad \frac{\partial \ln L}{\partial \ln \beta} = -\frac{1}{\sigma} \sum_1 \frac{X_t f_t}{F_t} + \frac{1}{\sigma^2} \sum_1 (Y_t - X_t\beta)X_t$$

$$(5\text{-}24) \qquad \frac{\partial \ln L}{\partial \ln \theta} = -\sum_0 \frac{X_t f_t(v)}{1 - F_t(v)} + \sum_1 \frac{X f_t(v)}{F_t(v)}$$

$$(5\text{-}25) \qquad \frac{\partial \ln L}{\partial \ln \sigma^2} = \frac{1}{2\sigma^3} \sum\nolimits_0 \frac{X_i \beta f_i}{F_i} - \frac{N_1}{2\sigma^2} + \frac{1}{2\sigma^4} \sum\nolimits_1 (Y_i - X_i\beta)^2$$

Maximum likelihood estimates of the parameters set, β, θ, and σ can be obtained given the likelihood function and its associated derivatives.

So far the error terms have been assumed to be independent. However, it is possible that, when unobserved characteristics of the household enters both equations, the error terms be correlated. In this case, in order to observe positive expenditure, the individual must be a potential consumer and actually consume the product. Thus, potential consumer may have zero consumption. This permits the possibility that zero consumption may arise as a result of either participation or consumption decisions(Blaylock and Blisard, 1992). The likelihood function of dependent double-hurdle model is

$$(5\text{-}26) \ \ln L = \sum\nolimits_0 \ln(1 - F(z_i\theta, X_i\beta/\sigma) + \sum\nolimits_1 \ln(\frac{1}{\sigma} f(Y_i - X_i\beta)) + \sum\nolimits_1 \ln(F(\frac{z_i\theta + \rho((Y_i - X_i\beta)/\sigma)}{(1 - \rho^2)^{0.5}}))$$

First-hurdle Dominance(Sample Selection) Model

An alternative approach to the dependent Cragg model is to assume that the two hurdles are dependent but the participation decision dominates the consumption decision. In this case zero consumption observation is viewed as a separate discrete variable. This is a Heckman or sample selection model that implies no individual is observed at a standard corner solution because, once the decision to participate is made, none of the zeros are a result of consumption decision. The following formal sample selection model clearly shows that property.

$$(5\text{-}27) \qquad Y_i^* = X_i\beta + \mu_i\,, \qquad D_i = z_i\theta + e_i$$

$$Y_i = Y_i^* \quad if \;\; D_i > 0,$$

$$=0 \quad if \;\; D_i \leq 0$$

In order to have positive dependent variable in the Double-hurdle model, consumers have to desire positive amount and should not have any barriers to consuming that product. That is, two hurdles have to be overcome to observe positive amount. But in the sample selection model, only the discrete decision variable, D needs to be greater than 0. Once the consumers decide to participate in the market, then it implies that the consumers' optimal amount is always positive. It rules out the possibility that consumers enters the market, but does not consume any because of unfavourable conditions(e.g. too high relative prices or too small budget). Double-hurdle models allow the existence of potential consumers who are currently out of the market.

Sample selection model implies that individuals with zero consumption provide no restrictions on the parameters of the consumption equation(Jones, 1989; Blaylock and Blisard, 1992; Burton et. al., 1993). Therefore, the Sample selection model is called the first-hurdle dominance model.

The first hurdle dominance model can be estimated using Heckman's two stage estimator. In the first stage probit regression is used to compute the Mill's ratio for each observation. Then, the Mill's ratio is employed as an instrument in the truncated second stage estimation. Even though the Heckman's two stage estimator is consistent, it is not efficient(Amemiya, 1984). However, the maximum likelihood estimator is efficient. The likelihood function for the Sample selection model is

$$(5\text{-}28) \qquad \ln L = \sum_0 \ln(1 - F(z_t\theta)) + \sum_1 \ln(\frac{1}{\sigma} f(Y_t - X_t\beta)) + \sum_1 \ln(F(\frac{z_t\theta + \rho((Y_t - X_t\beta)/\sigma)}{(1 - \rho^2)^{0.5}}))$$

If the dominance and independence are combined, the double-hurdle model collapses to a probit model for participation and OLS for the consumption equation. This is known as a "complete dominance model".

The simplified version of the double-hurdle model is similar with the Heckman's sample selection model. The only difference is that the former insure the non-negativity of Y as well as D, while the latter allows Y to take negative values(Heckman, 1979).

Purchase-infrequency Model

In the two previous sections, we have shown two ways of interpreting zero observations(expenditures) in a survey data: 1)Tobit specification, and 2)double-hurdle specification. The Tobit specification views zero observations as results of optimal behavior, while double-hurdle models imply that zero observations might indicate that the households are not participating in a certain market. If the zeros are results of discrete choices, that is, there are some noneconomic barriers to consuming the product under investigation, the households will not consume the product no matter how sharply the relative prices or income changes. The third way of interpreting zero observations(expenditures) can arise in a demand model where consumption is always positive but recorded expenditures are often zero. That is to say, when discrepancies between observed expenditures and unobserved consumptions exits, we need a model other than Tobit or double hurdle model.

Purchase-infrequency model has been developed by several researchers and used in consumption analysis of butter and cheese. A good example as an illustration of the appropriateness of purchase-infrequency model, given by Blundell and Meghir(1987), is clothing expenditure where consumption of services is very rarely zero but any survey of a limited period will record some zero expenditures due to the durability of clothing items and the resulting infrequency of purchase by individual consumers. The formal purchase-infrequency model is represented as

$$
\begin{aligned}
(5\text{-}29) \qquad y_i &= (y_i^* + w_i) \,/\, F(v) && \textit{if} \;\; y_i^* > 0 \;\; \textit{and} \;\; D_i > 0 \\
&= 0 && \textit{otherwise}
\end{aligned}
$$

$$
\begin{aligned}
\textit{here,} \qquad y_i^* &= x_i\beta + e_i \\
D_i &= z_i\theta + v_i
\end{aligned}
$$

Here, y_i is observed expenditures and y_i^* unobserved consumption level. The probit equation D_i represent an unobserved variable characterizing infrequent purchase cycle. D_i is greater than zero only if y_i is greater than zero. To derive the first line of the formal purchase-infrequency model, a brief explanation is needed. Expected value of observed expenditure y_i can be defined as

$$
\begin{aligned}
(5\text{-}30) \qquad E(y_i) &= E(y_i \mid D_i > 0)P_i + E(y_i \mid D_i \leq 0)(1 - P_i) \\
&= E(y_i \mid D_i > 0) \; P_i \\
&= E(y_i \mid D_i > 0)Pr(y_i > 0)
\end{aligned}
$$

P_i is the probability of purchase. The equality is true since the second term of above equation is identically zero. Now assuming that the expected value of expenditures, $E(y_i)$, is equal to the expected value of consumption, $E(y_i^*)$

$$E(y_i \mid D_i > 0)Pr(y_i > 0) = E(y_i^*) \tag{5-31}$$

$$\text{or} \qquad F(v)y_i = E(y_i^*)$$

Letting w_i capture random discrepancies in the process linking the observable dependent variable y_i with the corresponding latent variable y_i^*

$$\begin{aligned} F(v)y_i &= y_i^* + w_i \\ &= (x_i\beta + e_i) + w_i \end{aligned} \tag{5-32}$$

Thus, we derived the formal purchase-infrequency model. From this model, the contribution of the zero observations to the likelihood function is,

$$Pr(y_i = 0) = (1 - F(v))\, F(e) \tag{5-33}$$

The probability that consumption is zero can be represented as $(1 - F(v))$. However, since we have to account for the probability that consumption is positive but with no purchase occurring over the study period, we need to multiply the cumulative probability of positive observations, $F(e)$. For positive observations

$$\begin{aligned} Pr(y_i > 0)f(y_i \mid y_i > 0) &= Pr(D_i > 0)f(y_i \mid y_i^* > 0) \\ &= Pr(D_i > 0)f(y_i)/Pr(y_i^* > 0) \\ &= Pr(D_i > 0)f(y_i) \\ &= F(v)\, f(y_i - x_i\beta, \sigma^2) \\ &= F(v)|J|\, f(F(v)y_i - x_i\beta, \sigma^2) \end{aligned} \tag{5-34}$$

where J = F(v) is the Jacobian term in the equation (5-29). Finally, the likelihood function for the whole observations is

$$(5\text{-}35) \qquad \ln L = \textstyle\sum_0 [1 - F(x_i\theta)]\, F(x_i\beta/\sigma_e) + \sum_1 \ln \frac{1}{\sqrt{2\pi\sigma^2}} -$$

$$\textstyle\sum_1 \ln f[(F(x_i\theta)y_i - x_i\beta)] + \sum_1 + 2\ln F(x_i\theta)$$

Generalized Likelihood Function

Blundell and Meghir(1987) proposed a general likelihood function containing both the double-hurdle(market participation) and purchase-infrequency model. The general likelihood function shows that how, under certain restrictions, each of the two models are derived. It will also be demonstrated how the Tobit model is nested within the general likelihood function as well as within both the market participation and purchase infrequency model. The general likelihood function is composed of two probit equations and one expenditure equation. Assuming independence between the errors of the expenditure equation and the two probit equations, the general likelihood function is

$$(5\text{-}36) \qquad \ln L = \textstyle\sum_+ [-\ln\sigma_e + \ln f(F^1(r_i\alpha)y_i - x_i\beta/\sigma_e) + 2\ln F^1(r_i\alpha)$$

$$+ \ln F^2(z_i\theta)] + \textstyle\sum_0 [1 - F^1(r_i\alpha)F^2(z_i\theta)F^3(x_i\beta/\sigma_e)$$

where F^1 is the cumulative probability of the frequency of purchase(from the probit for the frequency of purchase), F^2 is the cumulative probability of market participation(from the probit for market participation), and F^3 is the cumulative probability of positive expenditures(from the normalized expenditures), and f is the density funcion for positive observations. Also, r_1, z_1, x_i refer to variables in the purchase-infrequency, market participation, and expenditure equations, respectively.

Upon imposing the restrictions that the cumulative probabilities of both the purchase frequency and market participation equal one , we can end up with standard Tobit model. The market participation model is derived with the assumption that the cumulative probability of the frequency of purchase is one($F^1 = 1$) over the sample. If every household uses the product($F^2 = 1$), the market participation model reduces to the Tobit model.

The purchase-infrequency models are obtained restricting the cumulative probability of market participation as one($F^2 = 1$). That is, the purchase-infrequency model assumes that all consumers use a commodity in question at one time or another. The purchase-infrequency model reduces to the standard Tobit model if the cumulative probability of the frequency of purchase is one($F^1 = 1$). This means that the survey period was long enough to observe all households replenish supplies except for those choosing a standard corner solution. Through the general likelihood function, the three models were shown to be closely related. Also, it was demonstrated that how the standard Tobit model is restrictive, and subsequently how it can distort the true behavioral pattern of food consumers.

Model Selection Tests

Tobit and double-hurdle models were proposed to model meat consumption decisions. It was shown that Tobit is a restricted version of double-hurdle model. It remains to be empirically tested whether the restrictions are valid.

One of the most popular approaches of hypotheses tests involving maximum likelihood estimates is the likelihood ratio(LR) test. The test statistics is given by

$$-2(L_R - L_U) \sim \chi^2_{df}$$

L_R is the likelihood value for the restricted model and L_U is for the unrestricted model. The sampling distribution of this statistic under the null hypothesis is asymptotically a chi-square distribution, with degrees of freedom equal to the number of restrictions imposed. The LR test can not be used when the two competing models are non-nested(e.g. double-hurdle vs. purchase-infrequency models).

Voung(1989) proposed a classical approach based on likelihood ratio tests which may be used for testing of both the nested and non-nested hypotheses. Assuming two conditional models(likelihood functions) of $f(y_t|x_i\beta)$ and $g(y_t|z_i\theta)$, he proposed tests of the null hypothesis that the two models are equivalent against that one is better than the other. The null hypothesis can be expressed as

$$(5\text{-}37) \qquad H_o : E[\ \log \frac{f(y_t|x_i;\beta)}{g(y_t|z_i;\theta)}\ ] = 0$$

The null hypothesis is tested against

$$(5\text{-}38) \qquad H_a : E\ [\ \log\frac{f(y_t|x_i;\beta)}{g(y_t|z_i;\theta)}\ ] >< 0$$

If the E[.] is greater than 0, it means that the likelihood function f is better than g.

Variance of the difference between the two likelihood functions(i.e., LR statistic) is defined as

$$(5\text{-}39) \qquad \omega_n^2 \equiv \frac{1}{n} \sum_{n=1}^{n} [\ \log \frac{f(y_t|x_i;\beta)}{g(y_t|z_i;\theta)}\ ]^2$$

$$-[\frac{1}{n} \sum_{n=1}^{n} \log \frac{f(y_t|x_i;\beta)}{g(y_t|z_i;\theta)}]^2$$

Then, the test statistic under the null hypothesis is

$$(5\text{-}40) \qquad Z_0 = \frac{LR_n(\beta,\ \theta)}{n^{1/2}\omega}$$

where Z_0 is a standard normal variable. This statistic is equal to the normalized difference between the maximum log-likelihood values of the two models. The normalization is equal to the square root of the variance of the LR statistic multiplied by the square root of the number of observations in the data set.

CHAPTER 6
ANALYSIS OF THE EMPIRICAL RESULTS AND SIMULATION

Introduction

This chapter involves the presentation and analysis of the parameter estimates of the various censored regression models proposed in the preceding chapter. The censored models were chosen over the OLS and other models to handle the zero observations in the NPD meat frequency data. One of the uniquenesses of this study lies in the utilization of attitudinal variables to investigate the preference structures of meat consumption across U.S. households. Accordingly, before estimation and model selection procedures are set forth, a discussion of the attitudinal variables and their expected roles in the households' consumption decisions is in order. While the primary concern is on the attitudinal variables, other explanatory variables including economic and sociodemographic will be described.

The second section succinctly explains the underlying implications of the several extentions of censored regression models regarding the zero observations. Model selection choices appropriate to the NPD meat frequency data are discussed. The third section presents and analyzes the parameter estimates of selected models from the Tobit, Double-hurdle, first-hurdle dominance(Sample selection), and complete dominance models. Then, using one of the proposed models, simulation analysis will be conducted to show how consumption frequencies across the meat category respond to the predetermined variations in attitudinal scales about health, beef promotion efforts, and selected demographics assuming certain levels for the variables not simulated. One of the purposes of the simulation analysis is to visualize the impacts of the range of variables. In particular, conceptual models for implicit linkage between beef checkoff expenditures and prices will be illustrated. Then simulation will be used to show the pattern of the marginal price changes corresponding to additional checkoff expenditures. Calculation of the marginal price changes is necessary to measure the revenue gains to producers.

Overview of Explanatory Variables

Five equations, one for each commodity(beef, pork, chicken, turkey, and fish) are estimated with the same set of independent variables with the only exception being the beef equation which includes advertising expenditures. Consumer demand is believed to be shaped by 1)economic, 2)sociodemographic, and 3)psychological(attitudinal) variables. Psychological variables are numerical scorings of psychological constraints consumers have toward product attributes which have been assumed to be fixed in traditional demand analysis. Now it is agreed that the psychological constraints could be relaxed by the aggressive advertising and the provision of new information about product attributes.

The whole set of independent variables can be grouped into eight smaller subsets: 1)indexes of attitudinal variables toward health and nutrition; 2)indexes of general eating behavior; 3)attitudes toward taste; 4)other psychological characteristics; 5)demographics; 6)economic variables(own and substitutes prices) including beef promotion efforts; 7)regional variables; and 8)time trend variables. Table 6-1 provides the variable names and their descriptions.

The first group of health-related variables are composed of NTCHL, NTFAT, NTADD, AND NTPRE.[6] Eating behavior variables are composed of FDHOT, FDPIZ, FDLUN, FDTAC, and FDFCH which are believed to be high in fats. Instead of using the two groups of original variables directly in the regression analysis, principal components corresponding to each group will be used to deal with the potential high correlations among the variables within each group. Up to two and three principal component vectors from the health-related and eating behavior variables will be used across the five meat categories. Other attitudinal variables(psychological characteristics) include ATDOC, ATREG, ATCAL, NTKNO, and NTPLN. They provide informations about other aspects of consumer attitudes toward health and nutritional issues as well as general perceptions.

Demographics selected for the regression analysis include DMMSZ, DMINC, DMHSZ, DMAGE, DMEDU, DMFEM, and DTFEM. A household is assumed to be closely knit group that behaves in such a way that justifies the existence of a household preference function(Samuelson, 1966). No prior economic theory gives specific indication of what kind of demographic variables to include in meat demand analysis and what to expect from the variables. Hence, the directions and magnitudes of the impacts of the demographic variables on meat demand are determined empirically.

Quarterly prices for beef, pork and poultry for the period from 84:1 through 93:4 were brought into the NPD database from external sources to address their impact on the household servings of meat in a two week period. Cross-sectional data possibly exhibit minimal price variations(Raunikar and Huang, 1987). Only regional differences in prices could be considered in

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[6] See chapter 3 for detailed descriptions of the attitudinal and demographic variables used in the empirical analysis.

Table 6.1 Description of the NPD and Related Data Included in the Model

Variable	Description
PCs*	Principal components from health-related variables
BHs	Principal components from eating behavior variables
ATDOC	Doctors give advice on diet
ATREG	Important to eat regular meals
ATCAL	Conscious of calories
NTKNO	Know more about nutrition than other
NTPLN	Plan nutritious meals
NTLOK	Most important food looks, smells, tastes good
DMMSZ	Market size(1=city of 1 million,...., 5=rural area)
NDMINC2	1 if the income is in the range between $20,000-$50,000
NDMINC3	1 if the income is above $50,000
DMAGE	Age of female head
DMEDU	Education of female head
DMHSZ	Household size
PPBF	Quarterly beef price
PPPL	Quarterly poultry price
PPPK	Quarterly pork price
DMFEM2	1 if female head is employed
DTFEM2	1 if female head is on diet
NDMREG2	1 if the survey region is Central
NDMREG3	1 if the survey region is South
NDMREG4	1 if the survey region is West
SQRTADV	Square root of quarterly advertising expenditures

* PCs include PC1 and PC2, while BHs include BH1, BH2, and BH3.

most of the cross-sectional analysis. Longitudinal nature of the NPD data alleviates this problem to some extent by allowing price variations over time.

Beef advertising expenditures have been included into the NPD database to consider the promotional impact on the number of household servings of beef. The nationwide beef checkoff program began in 1986, and advertising expenditures are a part of the checkoff money spent to promote the attributes of beef for the explicit purpose of supporting the demand for beef(Ward, 1994; Forker and Ward, 1993). For the purpose of econometric measurement of the impact on beef consumption, there has to be variation in the amount of advertising expenditures over the analysis period. Since there has been considerable year to year and within year differences in advertising expenditures over the study period, it poses no particular data problems(Ward, 1994).

In addition, a specification problem may arise when a linear relationship is used to measure the impact of advertising expenditures on beef consumption. Ward(1990) has shown that there is a maximum impact that could be expected from the checkoff programs. Linear models can not represent such a relationship. Taking the square root of the beef advertising expenditures is expected to partially alleviate shortcomings of the linear model for fitting the nonlinear relationship between the advertising expenditures and demand. Although there are nonlinear functional forms that guarantee decreasing marginal impact and the existence of a maximum impact, it adds excessive complexities in estimation to the already highly nonlinear likelihood functions of the censored models(see Ward(1992) for specific functional form). The square root of advertising has three desirable properties: 1)consumption remains even when expenditures equal zero, 2)the marginal responses decline with larger expenditures, and 3)the parameter for the square root function is linear in the model.

Nine regions were identified in the original NPD data. Rather than making nine regional dummy variables, they were regrouped into four larger regions: Northeast, Central, South, and West. The Northeast was used as a regional base in each meat category equation. Due to the disparities in tradition, environment, and availability of certain goods associated with location, the regions of the households are likely to account for differences in meat consumption patterns.

Since NPD Group started recording attitudes toward convenience only after 1990, this research could not use the variable, and failed to find a proxy that is reasonably correlated with the convenience variable. Thus variations in the attitudes toward convenience across households had to be omitted in addressing the issues of structural changes in consumer preferences for meat. However, since the NPD data ranges from 1984 to 1993, inclusion of a time trend variable can capture part of the changes in the frequency of meat consumption over time that can be attributed to the increased demand for convenience. The increased demand for convenience is expected to affect the consumption frequency of the five meat categories, depending on preparation time, packaging, use, and storability.

The health-related attitudinal variables are hypothesized to have negative impacts on red meat consumption(beef, and possibly pork) and a positive impact on white meat(chicken, turkey and fish) with the argument primarily based on fat and cholesterol differences. The indexes of eating behavior which were derived from a group of fat foods are expected to influence red meat consumption positively and white meat(including fish) in the negative direction. If the estimated parameters are statistically significant, the signs and magnitude of the parameters for both red and white meat will show the impact and relative importance of health and other variables shown above across the five meat categories. Particularly with respect to the health variables, if the estimated parameter signs are as hypothesized for both red and white meat, it indirectly supports the premise that increased health awareness is a factor driving changes in meat consumption trend over the last two decades. The confirmation may imply that consumers are willing to pay more for leaner products.

Those preference changes in consumer behavior require adjustments in every stage in the vertical system of the meat industry. For example, what cattle producers can do in response to the increased health awareness among consumers is to deliver beef with less external fat. Price premiums at the producer level are necessary to induce cattle producers to deliver beef with less external fat. Effective price transmission from the retail level to the producer depends on the grading pricing system for beef(Unnevehr and Bard, 1993). Hence, the preference changes bring the area of public policy into discussion. The public policy issues will be discussed in Chapter 7.

Model Comparisons

Tobit, first-hurdle dominance(sample selection), complete dominance, two versions of independent double-hurdle, and dependent double-hurdle models were estimated for each of the five meat categories.[7] Each model has different implications in reference to the zero observations. Tobit considers zeros as true optimal solutions, which connote that every consumer enters the market excluding the potential existence of non-consumers. The exclusion is an obvious restriction on modelling consumer behavior.

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[7] Two independent Double-hurdle models correspond to equations 5) & 6), and 7) & 9) from Cragg(1971).

Double-hurdle models allow the existence of non-consumers. Part of the zero reports are optimal responses to economic conditions and the remaining zeros being indications of discrete choices to not become consumers possibly because of psychological constraints(barriers).[8] The decisions to become consumers are embodied in the probit equation. In the first-hurdle dominance model, all of the zero observations are viewed as decisions not participate in the market. Likelihood functions clearly show the different implications of the zero observations in the two models. The complete dominance model simply adds the assumption of independence between the two stages to the first-hurdle dominance model. The second-stage of the complete dominance model can be estimated with ordinary least squares(OLS) using only positive observations. Together, the first-hurdle and complete dominance models are called dominance model.

Given the different model implications concerning the zero observations, it is in order to test and decide which model is appropriate to fit the NPD frequency data. Dependent double-hurdle models nest independent double-hurdle and Tobit models, while independent double-hurdle nests the Tobit model. The first-hurdle dominance model nests the complete dominance model. Accordingly, nested hypothesis testing procedures such as Likelihood ratio(LR), Wald, or Lagrangian multiplier(LM) tests are appropriate.

Since the double-hurdle and dominance models do not nest each other, the selection between the two should be based upon priori reasonings about the nature of the product under investigation and upon how the dependent variable is defined. Recalling, the dependent variable in the NPD data is defined as the number of servings or eatings of each meat category in a two week period. Two weeks should be long enough to consume meat at least once if the consumer is not a vegetarian. Hence, it seems logical, especially in the case of beef, to judge the zero observations as desires not to become consumers. This is particularly true since we are dealing with fresh meat. This points to the dominance models as the correct specification to fit the NPD frequency data.

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[8] Consumers may not use a product for any reasons including relative prices and budget constraints. But the most probable reasons might be psychological constraints.

Complete dominance models assume independence between the two error terms in the two-stages of participation and consumption, imposing a zero correlation coefficient between the two decisions. In contrast, the first-hurdle dominance model lets the data determine the correlation coefficient. Under the null hypothesis of a zero correlation coefficient, minus two times the difference between the two log likelihood values follows a chi-squared distribution with one degree of freedom, which is the number of restrictions imposed. To see if the restriction of a zero correlation coefficient in the complete dominance model is valid against the first-hurdle dominance model, LR tests were performed across the five meat categories. Table 6.2 shows the log likelihood values and test statistics for each of the five meat categories. The complete dominance model of zero correlation coefficient was rejected at $\alpha=0.05$ level against the first-hurdle dominance model in beef, pork, and chicken equations. In the cases of turkey and fish, complete dominance models were representing consumption behaviors as good as the first-hurdle dominance model. The test results demonstrate that it is necessary to account for simultaneity of the two-stage decision making processes for certain products.

Table 6.2 The First-hurdle Dominance Model vs. Complete Dominance Model

Meat Categories	-Log L Value of the First-hurdle Dominance Model	-Log L Value of the Complete Dominance Model	Chi-square Test Statistics(df=1)
Beef	41570.03	41585.63	χ^2 = 31.2
Pork	23252.5	23256.6	χ^2 = 8.2
Chicken	34387.9	34428.21	χ^2 = 80.6
Turkey	21135.6	21136.6	χ^2 = 2
Fish	24497.6	24498.7	χ^2 = 2.2

Note: Log likelihood values of the first-hurdle dominance model are from two-stage estimator. The critical χ^2 value at α=0.05 with one degree of freedom is 3.71.

In all of the five meat cagetories, estimation of the dependent double-hurdle model encountered convergence problem, and after a number of trial this model was abandoned. Even though two versions of the independent double-hurdle model had no convergence problems in all of the five meat categories, they had mixed results in terms of the signs and magnitudes of the parameter estimates of the explanatory variables.

Maximum likelihood estimation of the first-hurdle dominance model did not converge in the five meat categories, either. It is usually true, however, that, after a certain number of iterations, the parameter estimates do not change significantly. The signs were largely consistent across the Tobit, complete dominance, Heckman's two-stage and ML estimators. Thus, analysis of the parameter estimates of the five meat equations will be based upon the Tobit and dominance model. For the pork, turkey, and fish equations where part of ML estimates for the first-hurdle dominance model could not be obtained due to singularity of the data or derivatives, parameter estimates from two-stage method along with those of complete dominance model will be reported.

Analysis of the Estimated Parameters

In this section, parameter estimates for the five equations corresponding to beef, pork, chicken, turkey, and fish will be presented. Based on the signs and magnitudes of the estimated parameters of the eight subsets of explanatory variables, economic implications will be discussed. While qualitative interpretation is appropriate in this section, simulation analysis utilizing the magnitudes of the parameter estimates is the subject of the following section.

Parameter Estimates for the Beef Model

Besides the explanatory variables discussed in the introduction, three dummy variables representing time trends were created. The first dummy is one if the year is before 1987, the second(CK2) is 1 if the year is between 1987 and 1990, and the third(CK3) represents time shift after 1990. The first period was used as the dummy base. The partitions of the time period are based on actual observation of average annual consumption frequency(See Figure 3.1 in Chapter 3) and the weakened trend of declining beef consumption after 1990. Parameter estimates are reported in Table 6.3 for the Tobit, Heckman's two-stage, and ML estimation of Sample Selection.

It was shown in Chapter 3 that parameters of the principal components need to be multiplied by row vectors of factor loadings to recover the estimates of the original variables. The recovered estimates of the original variables for the Tobit and first-hurdle dominance models are shown in Tables 6.4, 6.5, and 6.6. Note that the original variables were standardized before computing the principal components and that the factor loadings were divided by the characteristic root to obtain a principal component with standard deviation of unity(TSP, 1990). Standard errors for the original variables

Table 6.3 Parameter Estimates of Tobit and Sample Selection Model for Beef.

Variables	Tobit	First-Hurdle Dominance(Sample Selection)			
		Two-Stage Estimator		ML Estimator	
		Probit	Consumption	Probit	Consumption
C	1.8913 (.5580)[a]	.3683 (.2884)	2.226 (.5732)	.2984 (.2114)	2.5139 (.6761)
PC1	.1888 (.0307)	.0452 (.0160)	.1931 (.0316)	.0556 (.0113)	.1684 (.0347)
PC2	.0618 (.0250)	-.0011 (.0126)	.0732 (.0240)	.0140 (.0091)	.0601 (.0292)
BH1	-.0616 (.0322)	-.0397 (.0164)	-.0528 (.0305)	-.0217 (.0120)	-.0571 (.0385)
BH2	-.0612 (.0257)	-.0485 (.0129)	-.0409 (.0257)	-.0279 (.0096)	-.0634 (.0302)
BH3	.0937 (.0253)	.0197 (.0128)	.0951 (.0235)	.0275 (.0095)	.0901 (.0303)
ATDOC	-.0354 (.0157)	-.0159 (.0081)	-.0326 (.0146)	-.0128 (.0059)	-.0363 (.0189)
ATREG	-.0957 (.0194)	-.0437 (.0098)	-.0863 (.0191)	-.0348 (.0073)	-.0981 (.0235)
ATCAL	.0835 (.0203)	.0144 (.0104)	.0883 (.0202)	.0250 (.0074)	.0875 (.0236)
NTKNO	.1257 (.0222)	.0698 (.0116)	.1057 (.0237)	.0477 (.0087)	.1388 (.0271)
NTPLN	-.1963 (.0257)	-.0425 (.0132)	-.1999 (.0261)	-.0544 (.0094)	-.1954 (.0302)
NTLOK	.0087 (.0159)	-.0030 (.0083)	.0133 (.0147)	-.0013 (.0060)	-.0008 (.0191)
DMMSZ	.1743 (.0155)	.0385 (.0082)	.1743 (.0162)	.0496 (.0060)	.1606 (.0185)
NDMINC2	.1645 (.0605)	.0883 (.0318)	.1532 (.0599)	.0366 (.0226)	.1113 (.0723)
NDMINC3	.1258 (.0720)	.1270 (.0381)	.0711 (.0712)	.0267 (.0280)	.1402 (.0905)
DMAGE	-.0148 (.0212)	.0310 (.0109)	-.0397 (.0215)	.0013 (.0081)	-.0136 (.0250)
DMEDU	-.2870 (.0293)	-.0730 (.0154)	-.2877 (.0306)	-.0779 (.0115)	-.2696 (.0356)
DMHSZ	1.033 (.0315)	.5048 (.0173)	.9335 (.0882)	.4388 (.0140)	.8721 .0378)
PPBF	-.0064 (.0029)	-.0037 (.0015	-.0056 (.0027)	-.0024 (.0011)	-.0072 (.0034)
PPPL	.0104 (.0055)	.0038 (.0029	.0102 (.0055)	.0047 (.2044)	.0134 (.0064)
PPPK	.0023 (.0024)	.0018 (.0013)	.0017 (.0024)	.0007 (.0009)	.0025 (.0028)

Table 6.3 continued

Variables	Tobit	First-hurdle Dominance(Sample selection)			
		Two-Stage Estimator		ML Estimator	
		Probit	Consumption	Probit	Consumption
TDMFEM2	-.3661	-.0942	-.3624	-.0909	-.3216
	(.0551)	(.0303)	(.0524)	(.0220)	(.0666)
DTFEM2	-.1807	-.0521	-.1946	-.0532	-.1453
	(.0574)	(.0298)	(.0516)	(.0218)	(.0695)
NDMREG2	.5527	.0676	.5842	.1528	.5296
	(.0725)	(.0388)	(.0678)	(.0288)	(.0896)
NDMREG3	.1269	-.0320	.1428	.0266	.1115
	(.0688)	(.0359)	(.0590)	(.0273)	(.0873)
NDMREG4	.2828	-.0415	.3283	.0471	.2330
	(.0795)	(.0403)	(.0694)	(.0309)	(.0998)
CK2[b]	-.8819	-.3637	-.8377	-.2628	-.8406
	(.1433)	(.0747)	(.1456)	(.0540)	(.1706)
CK3	-.8346	-.3188	-.8026	-.2403	-.7804
	(.1741)	(.0892)	(.1643)	(.0662)	(.2122)
SQRTADV	.7514	.5401	.6212	.2886	.8235
	(.3014)	(.1578)	(.2863)	(.1161)	(.3686)
SIGMA	3.151		2.7842[c]		3.4326
	(.0189)		(.5314)		(.0150)
RHO					.9993
					(.0480)
-Log L	40010.3	41570.03		40050.0	

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[a] Asymptotic standard errors are shown in parentheses below the parameter estimates.

[b] CK2 and CK3 are dummy variables representing the time period between 1987-1990 and after 1990, respectively.

[c] The variable is inverse mill's ratio. The coefficient is a multiplication of correlation coefficient and standard deviation of the disturbance term.

Table 6.4 Recovered Parameter Coefficients of the Original Variables from the Principal Component Estimates in the Tobit Model(See Table 3.1 for detailed variable definitions)

Original Variables	Recovered Parameter Estimates				
	Red Meat		White Meat[b]		
	Beef	Pork	Chicken	Turkey	Fish
HEALTH CONCERNS					
NTFAT[a]	0.0756	0.0394	-0.0060	-0.0636	-0.0241
NTCHL	0.0876	0.0418	-0.0040	-0.0817	-0.0288
NTADD	0.0135	0.0221	-0.0131	0.0207	-0.0011
NTPRE	-0.0012	0.0173	-0.0142	0.0392	0.0041
EATING BEHAVIOR					
FDHOT	-0.0068	-0.0386	0.0363	0.0858	0.0220
FDPIZ	-0.0722	0.0956	0.0775	-0.0391	0.0436
FDLUN	-0.0149	-0.0349	0.0280	0.0809	0.0234
FDTAC	-0.0059	0.0396	0.0213	0.0097	0.0407
FDFCH	-0.0800	-0.0684	-0.0213	0.1090	0.0243

[a] Recall the scorings where 1=completely concerned about fats, 2=mostly concerned, 3=somewhat concerned, 4=neither, 5=somewhat not concerned, and 6=completely not concerned. Thus, for example, with fats a positive sign implies more servings with less concern over fats.

[b] The full coefficients estimates are reported later in this chapter.

Table 6.5 Recovered Parameter Coefficients of the Original Variables from the Principal Components Estimates in the Probit Part of the First-hurdle Dominance Model

Original Variables	Recovered Parameter Estimates				
	Red Meat		White Meat		
	Beef	Pork	Chicken	Turkey	Fish
HEALTH CONCERNS					
NTFAT	0.0099	0.0111	-0.0006	-0.0229	-0.0149
NTCHL	0.0094	0.0097	0.0012	-0.0295	-0.0185
NTADD	0.0104	0.0147	-0.0075	0.0078	-0.0023
NTPRE	0.0101	0.0149	-0.0088	0.0146	0.0062
EATING BEHAVIOR					
FDHOT	-0.0214	-0.0156	0.0117	0.0243	0.0086
FDPIZ	-0.0273	0.0413	0.0355	-0.0105	0.0157
FDLUN	-0.0186	-0.0139	0.0084	0.0229	0.0094
FDTAC	-0.0126	0.0178	0.0093	0.0028	0.0164
FDFCH	-0.0252	-0.0278	-0.0137	0.0304	0.0114

Table 6.6 Recovered Parameter Coefficients of the Original Variables from the Principal Components Estimates in the Second-stage of the First-hurdle Dominance Model

Original Variables	Recovered Parameter Estimates				
	Red Meat		White Meat		
	Beef	Pork	Chicken	Turkey	Fish
HEALTH CONCERNS					
NTFAT	0.0685	0.0204	-0.0051	-0.0146	-0.0083
NTCHL	0.0795	0.0228	-0.0042	-0.0189	-0.0094
NTADD	0.0118	0.0668	-0.0077	0.0055	-0.0024
NTPRE	-0.0017	0.0634	-0.0080	0.0099	-0.0009
EATING BEHAVIOR					
FDHOT	0.0036	-0.0153	0.0278	0.0297	0.0107
FDPIZ	0.0574	0.0388	0.0539	-0.0142	0.0226
FDLUN	-0.0060	-0.0142	0.0218	0.0279	0.0115
FDTAC	-0.0136	0.0147	0.0152	0.0024	0.0211
FDFCH	-0.0682	-0.0292	-0.0125	0.0024	0.0121

can be calculated from the following formula(Chatterjee and Price, 1981).

$$(6-1) \qquad Var(\beta) = (\sum \frac{\beta_i^{*2}}{\lambda_i})\sigma^2$$

In equation (6-1) β is a vector of parameter estimates of original variables, $\beta*$ for the principal components, and λ_i is ith characteristic root.

The coefficient estimates of the first two principal components from the Tobit model in Table 6.3 clearly show that composite effect of health concerns on beef consumption was statistically significant and negative. The more strongly the households agree that considerations of fat, cholesterol, additives, and preservatives are important, the less frequently the households served beef. The parameter estimates of original variables computed in Table 6.3, 6.4 and 6.5 confirm that the direction of the impacts of the separate variables are consistent with the composite effects except for the case of preservatives. The results are valuable given that there have not been enough rigorous empirical studies showing the impact of health concerns on beef consumption, although a lot of unscientific speculations about the potential linkage have been made.

The first-hurdle dominance model had significant first principal components, while the second principal components were not. To examine if the composite impacts of health concerns collectively had significant impacts in participation and consumption decisions, three hypotheses were established: 1)H_o:coefficients of PC1 and PC2 are zeros in both stages, 2)H_o:coefficients of PC1 and PC2 are zeros in participation equation, 3)H_o:coefficients of PC1 and PC2 are zeros in consumption equation. The first hypothesis is that health concerns were not collectively significant either in hindering households from participating in the beef market or in reducing the intensity of consumption by participants. The second hypothesis signifies that the health concerns had a measurable impact only on the intensity of consumption, having no impact on the decisions of whether to enter the beef market or not. The last hypothesis is a reverse of the second. Table 6.7 shows log likelihood values corresponding to the unrestricted and three restricted models along with test statistics for each hypothesis. All three hypotheses were rejected at the α=0.05 confidence level.

Table 6.7 Likelihood Ratio Tests for the Significance of Health Concerns in the First-Hurdle Dominance Model for Beef

Models	-Log Likelihood Values[a]	Test Statistics
Unrestricted	41570.03	
Restricted (i)[b]	41594.93	$\chi^2_{df=4} = 49.8$
Restricted (ii)	41574.04	$\chi^2_{df=2} = 8.2$
Restricted (iii)	41590.93	$\chi^2_{df=2} = 41.8$

[a] the log likelihood values are from Heckman's two-stage estimator. Critical values at α=0.05 with degrees of freedom equal to four and two are 9.49 and 5.99 respectively.

[b] Restriction (i) stand for zero coefficients of PC1 and PC2 in both stages, restriction (ii) for zero coefficients of the two principal components only in participation equation, and (iii) for zero coefficients only in consumption equation.

The test results showed that health concerns were one of the barriers that prohibit consumers from participating in the beef market, and it was also significant in reducing the desire(intensity) to consume beef. The results are consistent with the expectation that, while there might be consumers who do not eat beef because of reasons including health concerns, other consumers would respond to the health concerns just by decreasing the number of servings of beef. A similar interpretation was not possible with the Tobit model because it assumes that every consumer is participating in the beef market. That is, the Tobit model rules out the possibility that zero observations might be the results of discrete decisions not to consume beef.

Variables other than composite indexes of health concerns also had consistent signs across the three models. The first two principal components of general eating behavior variables have positive impacts, as expected. The recovered estimates for the original variables shown in Table 6.4, 6.5, and 6.6 consolidate the positive association between the set of eating behavior variables and beef consumption. The stronger the households encourage eating fried chicken, tacco, hotdog, and luncheon meat, the more frequently the households served beef. This confirms the expection that eating habits play a significant role in making beef consumption decisions.

The group of other attitudinal variables also had expected signs with statistically significant impacts on the number of beef servings per capita per household. First, doctor's advice on diet(ATDOC), eating regular meals(ATREG), knowledge about nutrition(NTKNO), and awareness of calories(ATCAL) were all negatively associated with household beef consumption, strongly confirming that the more the households are concerned about other health issues than fat, cholesterol, preservatives, and additives, the less frequently they consume beef. In particular, the direction of the impact of NTKNO shows that if knowledges of nutritional contents(attributes) of foods are considered important, the households served beef less frequently. Whether this implies negative attitudes about beef or the selection of more variety is not known.

The more strongly the households agreed that planning of nutritious meals is important, the greater were the chances to eat beef. This result suggests that the households consider beef one of the nutritious food items. Planning along with the nutrition knowledge suggest that the negative knowldge in the past must be relooked to desire for variety more than for "bad" nutritional attitudes about beef. Otherwise, the inclusion of more beef when planning meals should be of the opposite sign.

Counter to expectations, the taste variable(NTLOK) did not have a significant impact on beef consumption. It had been expected that consumers value taste as one of the positive attributes of beef, thereby contributing to offseting the trend of declining beef consumption.

Market size(DMMSZ) turned out to be statistically significant in determining the frequency of beef consumption. As market size grows, the households served beef less frequently on a per capita basis. There can be several explanations for this result. Rural areas have greater chances to preserve traditional life styles where beef is a major part of family meals. Also, big cities generally provide greater varieties of foods and opportunities for different eating experiences.

While education of female head(DMEDU) had significant negative impact, the age of female head(DMAGE) did not have a significant influence on the frequency of beef consumption. The negative significance of the education of female head is in accord with the finding by Lee(1987) that college education for female head may reduce the household's likelihood of consuming red meat at home. Household size(DMHSZ) was positively significant, indicating that consumers in larger family size served beef more frequently than those in smaller sized households. In accord with a *priori* expectation, if female heads were on a diet, the households consumed beef less frequently.

The presence of employed female(DMFEM) heads in the households significantly decreased the frequency of beef servings. If there are fewer beef products convenient to cook than white meats, then this is in agreement with the household production theory which argues that time is one of the inputs along with purchased goods and services to produce cooked and served meals(Becker, 1965; Bryant, 1992).

Concerning regional variables, if the households are located in Central region, they are more likely to consume beef than any other region. Dummy variables representing South and West in the Sample selection model did not have statistically significant different impacts on the number of beef servings.

In the Tobit model, the income category of $20,000-$50,000 had a statistically significant and positive impact on the frequency of household beef consumption, while the category of above $50,000 had positive but insignificant impact. Time-series analyses of beef demand show that income elasticity of beef demand is positive. Since time series analyses are based on averaged income and consumption over a certain period of time, the elasticity measures average consumption responses, ignoring potentially differential intensity of responses from different income classes. That is, the elasticity does not capture how beef consumption responds to different income categories. Unlike the time-series data, analysis using households survey data can clearly evaluate the differential impacts of different income categories on beef consumption. According to the above statistical results, frequency of beef consumption in the middle income group responded most sensitively, while the high income group exhibited insignificant responses. The differences in the intensity of responses are not surprising because beef is not a luxury good.

As mentioned in the introduction section, quarterly national average prices were brought into NPD database. In agreement with the findings of most time series studies, beef prices had a statistically significant negative impact on the frequency of household beef servings. This result was remarkable considering that the dependent variable was defined as the number of beef serving in a two week period rather than usual USDA disappearance data. The strong statistical association between the two variables demonstrates that price really enters household beef serving decision-making. Pork price was not significant in the beef equation, although it had the expected sign.

Time adjustment variables had statistically significant and negative impact on the household beef servings, suggesting that there are still other factors excluded from this model that affect negatively the frequency of beef servings. For example, increased demand for convenience and diversified diet over the recent decades could have contributed to the negative time trend. This result is consistent with the significant negative trend in analyses using market disapperances data.

Finally, the effect of advertising expenditures on the frequency of household beef servings was evaluated by bringing the expenditures data into the NPD database. The impact was positive and statistically significant. This result supports the findings by Ward(1992, 1994) that the beef checkoff programs have caused a measurable and significant shift for beef over the period between 1987 and 1993. More details about the advertising impact follows in the next section. Without the time trend variables, the sign of the advertising expenditures was negative. The negative sign was most likely because of the coincidence that the expenditures increased sharply after 1987 and the average beef consumption frequency of the NPD data has dropped considerably starting from 1987. Consequently, the increases in advertising expenditures was picking up part of the declining household beef consumption trend which has not been explained by other explanatory variables.

Parameter Estimates of Pork

Pork equations included the same set of explanatory variables as in beef except for the time trend variable, WAVE. WAVE corresponds approximately to calendar months from March 1984 to April 1993. Parameter estimates of the Tobit, first-hurdle dominance(Heckman's two-stage), and complete dominance model are shown in Table 6.8. The composite effects of health concerns on the per capita servings of pork were negative across the three models, and only the first principal components were significant. The signs of the recovered parameter estimates for original variables in Table 6.4 demonstrate that concerns about fat, cholesterol, additives, and preservatives were negatively associated with pork consumption. To investigate whether the negative composite effects were collectively significant, a LR test was performed, and identical hypotheses were established as in beef. Table 6.9 shows the necessary informations and test statistics. The three restricted models were all rejected at a conventional confidence level(α=0.05), indicating that the composite effects of health concerns were statistically significant in both stages of behavior. The consistently significant negative impacts on the consumption frequency across pork and beef support the general expectation that health concerns have decreased the overall consumption of red meat.

The directions of the impacts of other attitudinal and demographic variables were also almost identical to the beef case. The only differences

Table 6.8 Parameter Estimates of Tobit, Heckman's Two-Stage, and Complete Dominance Model for Pork.

Variables	Tobit	First-hurdle Dominance (Two-stage estimator)		Complete Dominance
		Probit	Consumption	Consumption
C	-2.6179 (.5140)[a]	-1.0879 (.2482)	-4.1456 (2.2686)	.9182 (.3853)
PC1	.1337 (.0253)	.0574 (.0122)	.1705 (.0587)	.0459 (.0187)
PC2	.0160 (0208)	-.0046 (.0100)	.0326 (.0179)	.0420 (.0159)
BH1	-.0266 (.0268)	-.0053 (.0129)	-.0391 (.0215)	-.0285 (.0208)
BH2	-.1286 (.0215)	-.0546 (.0103)	-.1654 (.0547)	-.0441 (.0165)
BH3	.0711 (0211)	.0297 (.0101)	.0911 (.0324)	.0265 (.0162)
ATDOC	.0199 (.0130)	.0061 (.0063)	.0270 (.0116)	.0144 (.0097)
ATREG	-.0869 (.0163)	-.0340 (.0078)	-.1149 (.0347)	-.0401 (.0123)
ATCAL	.0719 (.0170)	.0262 (.0082)	.1007 (.0276)	.0440 (.0129)
NTKNO	.1068 (.0184)	.0562 (.0089)	.1190 (.0565)	-.0039 (.0138)
NTPLN	-.2197 (.0214)	-.0987 (.0103)	-.2719 (.0967)	-.0557 (.0160)
NTLOK	-.0157 (.0131)	-.0162 (.0064)	-.0106 (.0175)	.0248 (.0097)
DMMSZ	.0352 (0129)	.0102 (.0062)	.0477 (.0142)	.0243 (.0095)
NDMINC2	.0233 (.0501)	.0468 (.0243)	-.0119 (.0578)	-.1174 (.0372)
NDMINC3	.0674 (.0597)	.0660 (.0289)	.0290 (.0779)	-.1239 (.0445)
DMHSZ	.4392 (.0265)	.2322 (.0127)	.4946 (.2259)	-.0189 (.0206)
DMAGE	.1298 (.0177)	.0645 (.0085)	.1502 (.0644)	.0063 (.0135)
DMEDU	-.1843 (.0243)	-.0908 (.0117)	-.2224 (.0910)	-.0224 (.0181)
TDMFEM2	-.0651 (.0453)	.0019 (.0220)	-.1105 (.0328)	-.1101 (.0334)
DTFEM2	-.0771 (.0475)	-.0121 (.0230)	-.1272 (.0362)	-.1034 (.0355)

Table 6.8 Continued

Variables	Tobit	First-hurdle Dominance (Two-stage estimator)		Complete Dominance
		Probit	Consumption	Consumption
PPBF	.0103 (.0024)	.0040 (.0012)	.0137 (.0043)	.0049 (.0018)
PPPL	.0055 (.0042)	.0025 (.0020)	.0071 (.0039)	.0019 (.0032)
PPPK	-.0087 (.0020)	-.0038 (.0009)	-.0108 (.0039)	-.0023 (.0015)
NDMREG2	.2979 (.0597)	.0975 (.0290)	.4159 (.1014)	.2081 (.0440)
NDMREG3	.1552 (.0571)	.0240 (.0275)	.2491 (.0451)	.1971 (.0427)
NDMREG4	-.1024 (.0669)	-.0913 (.0320)	-.0844 (.1034)	.1202 (.0511)
WAVE	-.0005 (.0004)	-.0002 (.0002)	-.0006 (.0004)	-.0002 (.0003)
SIGMA	2.3056 (.0216)		3.3216[b] (1.4454)	
RHO				
-LOG L	22195.6	23252.5		23256.6

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[a] Asymptotic standard errors are shown in parentheses below the parameter estimates.

[b] The variable is inverse mill's ratio. The coefficient is a multiplication of correlation coefficient and standard deviation of the disturbance term.

Table 6.9 LR Test for the Significance of Health Concerns in the First-hurdle Dominance Model for Pork

Models	-Log Likelihood Values[a]	Test Statistics
Unrestricted	23252.5	
Restricted (i)[b]	23272.3	$\chi^2_{df=4}$ = 40.4
Restricted (ii)	23261.3	$\chi^2_{df=2}$ = 18.4
Restricted (iii)	23263.3	$\chi^2_{df=2}$ = 22.4

[a] the log likelihood values are from Heckman's two-stage estimator. Critical values at $\alpha=0.05$ with degrees of freedom equal to four and two are 9.49 and 5.99 respectively.

[b] Restriction (i) stands for zero coefficients of PC1 and PC2 in both stages, restriction (ii) for zero coefficients of the two principal components only in participation equation, and (iii) for zero coefficients only in consumption equation.

were that the age of female head had a significant positive impact, and that the dummy variables for the middle and high income groups did not have significant impacts(the age of female head was not significant in the beef equation). The time trend variable, WAVE, was not different from zero, suggesting that there has been no significant negative trend in the per capita pork servings that is at least not captured with the other variables in the model.

Parameter Estimates of White Meat

The first principal component of health concern variables had statistically significant and positive impact on the per capita frequency of chicken servings in the Tobit, and in both participation and consumption stages in the first-hurdle dominance model. The second principal component was not statistically significant across the models. Thus, the composite indexes of health concerns produced ambigous signals regarding the significance of the impacts of health concerns on chicken consumption. To decide whether the health concerns were collectively significant, the same hypotheses as in beef were tested. Table 6.10 presents the test results, and Table 6.11 and 6.13 show the parameter estimates for the chicken and turkey models. Recall that the health concerns were expected to be positively associated with chicken consumption mostly because of the diet change of the households away from red meat. That is, chicken was hypothesized to be a close substitute in response to negative impacts of health concerns on red meat consumption.

All of the three hypotheses could not be rejected at conventional significance level, saying that the health concerns compositely did not have appreciable impacts in either the participation or consumption stages. Even though the signs of the principal components of health concerns were positive, the insignificance of the composite effects shows that the impact of health concerns on red meat and poultry was asymmetric. The asymmetric impact might suggest that the increased poultry consumption over the last twenty years was not an outgrowth of the substitute effect from health concerns away from red meat.

Table 6.10 LR Test for the Significance of Health Concerns on Chicken Consumption in the First-hurdle Dominance Model

Models	-Log Likelihood Values	Test Statistics
Unrestricted	34387.9	
Restricted (i)	34390.83	$X^2_{df=4}$ =3.07
Restricted (ii)	34389.23	$X^2_{df=2}$ =2.63
Restricted (iii)	34388.23	$X^2_{df=2}$ =0.33

[a] the log likelihood values are from Heckman's two-stage estimator. Critical values at α=0.05 with degrees of freedom equal to four and two are 9.49 and 5.99 respectively.

[b] Restriction (i) stands for zero coefficients of PC1 and PC2 in both stages, restriction (ii) for zero coefficients of the two principal components only in participation equation, and (iii) for zero coefficients only in consumption equation.

A noticeable result among the demographic variables was that, as market size grows, the households served chicken more frequently, which is contrasting to the results in beef and pork. One of the possible explanations for this can be the greater availability of chicken in fast food establishments in larger cities.

In reference to the impacts of health concerns on turkey consumption frequency, the signs of the two principal components in the Tobit model turned out to be positive and significant. In the first-hurdle dominance model, the health concerns had significant and positve impact only on the decisions to enter the turkey market, and the impact on the intensity of turkey consumption was not significant. The LR test shown in Table 6.12 confirms the t-tests result about the significances of the principal components only on the probit part. The statistically significant positive impacts on the first-stage decision implies that more households entered the turkey market in the consideration of health, suggesting that turkey was perceived as containing mainly less fat and cholesterol.

Parameter Estimates of Fish

In the fish equation, health concerns also had positive signs across the Tobit and first-hurdle dominance model as in chicken and turkey. The first principal component was significant in the Probit part of the first-hurdle dominance model, while both of the principal components were not significant in the second-stage decisions. Parameter estimates for the fish model is shown in the Table 6.14. The significance of the collective impacts of health concerns in each stage can be determined by LR test. Table 6.15 shows the test results. The results reveal that health concerns stimulated the households to participate in the fish market, having no measurable impact on the intensity of fish consumption.

In this section, the models were presented with emphasis given to the beef. Since our primary focus of the research is the beef market, the beef results will be explained in more detail in the next section. Specifically, simulation procedures will be used to provide greater insight into those variables showing major impacts on the use of beef within U.S. households.

Table 6.11 Parameter Estimates of Tobit and First-Hurdle Dominance Model for Chicken

Variables	Tobit	First-hurdle Dominance			
		Two-stage Estimator		ML Estimator	
		Probit	Consumption	Probit	Consumption
C	-.2285 (.4711)[a]	-.2956 (.2658)	-5.2783 (.9590)	-.2545 (.2169)	.2672 (.5190)
PC1	-.0434 (.0234)	-.0189 (.0130)	-.0909 (.0218)	-.0246 (.0107)	-.0552 (.0258)
PC2	.0080 (.0190)	.0075 (.0106)	.0247 (.0169)	.0097 (.0087)	.0188 (.0211)
BH1	.1803 (.0245)	.0638 (.0139)	.3629 (.0367)	.0967 (.0112)	.2545 (.0270)
BH2	-.0274 (.0196)	-.0178 (.0110)	-.0724 (.0193)	-.0005 (.0089)	.0072 (.0215)
BH3	.0645 (.0193)	.0305 (.0108)	.1455 (.0222)	.0294 (.0088)	.0729 (.0213)
ATDOC	-.0019 (.0120)	-.0013 (.0068)	-.0052 (.0102)	-.0024 (.0055)	-.0053 (.0132)
ATREG	-.0704 (.0148)	-.0174 (.0083)	-.1228 (.0143)	-.0347 (.0068)	-.0949 (.0164)
ATCAL	.0304 (.0155)	.0131 (.0087)	.0685 (.0143)	.0043 (.0071)	.0128 (.0171)
NTKNO	.0279 (.0170)	.0256 (.0095)	.0863 (.0191)	.0118 (.0078)	.0185 (.0187)
NTPLN	-.1848 (.0197)	-.0893 (.0109)	-.4278 (.0445)	-.0779 (.0090)	-.1922 (.0217)
NTLOK	.0027 (.0121)	.0011 (.0069)	.0049 (.0105)	.0039 (.0056)	.0031 (.0134)
DMMSZ	-.0534 (.0119)	-.0245 (.0067)	-.1175 (.0140)	-.0224 (.0055)	-.0591 (.0131)
NDMINC2	-.0666 (.0462)	.0152 (.0258)	-.0471 (.0390)	-.0760 (.0213)	-.2150 (.0510)
NDMINC3	-.0176 (.0549)	.0811 (.0312)	.1477 (.0582)	-.0690 (.0256)	-.2356 (.0605)
DMAGE	.0213 (.0162)	.0225 (.0090)	.0772 (.0188)	.0040 (.0074)	-.0033 (.0178)
DMEDU	.0360 (0223)	.0030 (.0127)	.0460 (.0195)	.0154 (.0103)	.0255 (.0246)
DMHSZ	.3738 (.0240)	.2690 (.0135)	1.0303 (.1250)	.1683 (.0117)	.1642 (.0267)
PPBF	.0056 (.0023)	.0024 (.0013)	.0123 (.0021)	.0016 (.1035)	.0056 (.0025)
PPPL	.0063 (.0039)	.0019 (.0022)	.0113 (.0033)	.0026 (.0018)	.0060 (.0043)

Table 6.11 Continued

Variables	Tobit	First-hurdle Dominance			
		Two-stage Estimator		ML Estimator	
		Probit	Consumption	Probit	Consumption
PPPK	-.0035	-.0013	-.0071	-.0014	-.0037
	(.0018)	(.0010)	(.0016)	(.0008)	(.0020)
TDMFEM2	-.2627	-.1062	-.5444	-.1028	-.2770
	(.0420)	(.0240)	(.0571)	(.0196)	(.0463)
DTFEM2	.3367	.1398	.6981	.1921	.4728
	(.0435)	(.0251)	(.0021)	(.0201)	(.0479)
NDMREG2	-.3562	-.1974	-.8632	-.1079	-.2466
	(.0552)	(.0314)	(.0944)	(.0256)	(.0609)
NDMREG3	.0455	-.0604	-.0600	.0991	.3040
	(.0521)	(.0301)	(.0492)	(.0244)	(.0575)
NDMREG4	-.2601	-.1545	-.6467	-.0969	-.1890
	(.0602)	(.0342)	(.0805)	(.0279)	(.0664)
WAVE	.0002	.00007	.0004	.0003	.0007
	(.0004)	.00022)	(.0003)	(.0002)	(.0004)
SIGMA			8.2000[b]		2.5619
			(.9741)		(.0252)
RHO					.9942
					(.0017)
-LOG L	32676.7	34387.9		32395.9	

[a] Asymptotic standard errors are shown in parentheses below the parameter estimates.

[b] The variable is inverse mill's ratio. The coefficient is a multiplication of correlation coefficient and standard deviation of the disturbance term.

Table 6.12 LR Test for the Significance of Health Concerns in the First-hurdle Dominance Model for Turkey.

Models	-Log Likelihood Values	Test Statistics
Unrestricted	21135.6	
Restricted (i)	21143.1	$\chi^2_{df=4}$ = 15.0
Restricted (ii)	21142.6	$\chi^2_{df=2}$ = 14.0
Restricted (iii)	21136.1	$\chi^2_{df=2}$ = 1.0

[a] the log likelihood values are from Heckman's two-stage estimator. Critical values at α=0.05 with degrees of freedom equal to four and two are 9.49 and 5.99 respectively.

[b] Restriction (i) stands for zero coefficients of PC1 and PC2 in both stages, restriction (ii) for zero coefficients of the two principal components only in participation equation, and (iii) for zero coefficients only in consumption equation.

Table 6.13 Parameter Estimates of Tobit, First-Hurdle Dominance Model and Complete Dominance Model for Turkey

Variables	Tobit	First-hurdle Dominance (Two-stage Estimator)		Complete Dominance
		Probit	Consumption	Consumption
C	-4.9814 (.7979)[a]	-1.6967 (.2559)	-7.3405 (7.2738)	2.2987 (.6346)
PC1	-.0835 (.0402)	-.0292 (.0129)	-.0952 (.0845)	.0078 (.0327)
PC2	-.0867 (.0324)	-.0316 (.0104)	-.0975 (.0862)	.0125 (.0263)
BH1	.3451 (.0414)	.0979 (.0133)	.4662 (.2565)	.1254 (.0323)
BH2	.1203 (.0330)	.0336 (.0106)	.1662 (.0914)	.0504 (.0261)
BH3	-.0657 (.0329)	-.0180 (.0105)	-.0922 (.0546)	-.0311 (.0261)
ATDOC	.0053 (.0204)	.0015 (.0066)	.0049 (.0168)	.0004 (.0164)
ATREG	-.0265 (.0252)	-.0044 (.0081)	-.0417 (.0208)	-.0268 (.0200)
ATCAL	.0239 (.0266)	.0058 (.0085)	.0347 (.0265)	.0151 (.0218)
NTKNO	-.0494 (.0289)	-.0106 (.0093)	-.0791 (.0359)	-.0427 (.0233)
NTPLN	-.2060 (.0337)	-.0596 (.0108)	-.2762 (.1603)	-.0656 (.0274)
NTLOK	-.0179 (.0205)	-.0046 (.0066)	-.0282 (.0205)	-.0117 (.0163)
DMMSZ	-.0047 (.0201)	-.0088 (.0065)	.0075 (.0287)	.0379 (.0158)
NDMINC2	.2347 (.0788)	.0583 (.0252)	.3441 (.1701)	.1353 (.0635)
NDMINC3	.3873 (.0919)	.1156 (.0296)	.5171 (.3010)	.1189 (.0722)
DMAGE	.1035 (.0275)	.0335 (.0088)	.1350 (.0921)	.0180 (.0221)
DMEDU	.1137 (.0378)	.0366 (.0121)	.1469 (.0990)	.0226 (.0298)
DMHSZ	.3615 (.0407)	.1574 (.0130)	.3457 (.4149)	-.2017 (.0327)
PPBF	-.0061 (.0039)	-.0017 (.0012)	-.0078 (.0058)	-.1301 (.0032)
PPPL	.0031 (.0066)	.0013 (.0021)	.0029 (.0067)	-.0020 (.0053)
PPPK	.0147 (.0030)	.0045 (.0010)	.0197 (.0122)	.0038 (.0053)

Table 6.13 Continued

Variables	Tobit	First-hurdle Dominance (Two-stage Estimator)		Complete Dominance
		Probit	Consumption	Consumption
TDMFEM2	-.0759 (.0707)	-.0011 (.0228)	-.1374 (.0530)	-.1340 (.0553)
DTFEM2	.3810 (.0727)	.1318 (.0235)	.4554 (.3405)	.0058 (.0567)
NDMREG2	-.0740 (.0931)	-.0308 (.0299)	-.0907 (.1072)	.0158 (.0737)
NDMREG3	-.2704 (.0885)	-.0945 (.0284)	-.3396 (.2537)	-.0133 (.0703)
NDMREG4	.2000 (.1001)	.0542 (.0323)	.2519 (.1507)	.0687 (.0780)
WAVE	.0020 (.0007)	.0006 (.0002)	.0026 (.0016)	.0005 (.0005)
SIGMA	3.3463 (.0371)		4.8367[b] (3.6044)	
RHO				
-LOG L	19753.5	21135.6		21136.2

[a] Asymptotic standard errors are shown in parentheses below the parameter estimates.

[c] The variable is inverse mill's ratio. The coefficient is a multiplication of correlation coefficient and standard deviation of the disturbance term.

Table 6.14 Parameter Estimates of Tobit, First-Hurdle Dominance Model and Complete Dominance Model for Fish

Variables	Tobit	First-hurdle Dominance (Two-stage Estimator)		Complete Dominance
		Probit	Consumption	Consumption
C	-.0702 (.4787)[a]	-.2704 (.2456)	-.6112 (2.0726)	2.4498 (.3531)
PC1	-.0530 (.0238)	-.0254 (.0121)	-.0657 (.0396)	-.0134 (.0183)
PC2	-.0232 (.0194)	-.0176 (.0099)	-.0207 (.0272)	.0126 (.0263)
BH1	.2033 (.0248)	.0815 (.0128)	.2621 (.1111)	.1254 (.0323)
BH2	-.0231 (.0198)	-.0081 (.0101)	-.0333 (.0186)	.0505 (.0261)
BH3	.0025 (.0194)	-.0012 (.0100)	.0040 (.0154)	-.0311 (.0261)
ATDOC	-.0042 (.0121)	.0054 (.0062)	-.0119 (.0116)	.0004 (.0164)
ATREG	-.0479 (.0151)	-.0134 (.0077)	-.0671 (.0202)	-.0268 (.0200)
ATCAL	.0454 (.0158)	.0162 (.0080)	.0615 (.0251)	.0151 (.0218)
NTKNO	.0078 (.0172)	.0097 (.0088)	.0020 (.0185)	-.0427 (.0233)
NTPLN	-.1998 (.0200)	-.0920 (.0102)	-.2499 (.1268)	-.0656 (.0274)
NTLOK	-.0126 (.0123)	-.0067 (.0063)	-.0150 (.0126)	-.0117 (.0163)
DMMSZ	-.0447 (.0121)	-.0213 (.0062)	-.0572 (.0296)	.0379 (.0158)
NDMINC2	.0512 (.0470)	.0221 (.0239)	.0600 (.0480)	.1353 (.0635)
NDMINC3	.2047 (.0555)	.1079 (.0284)	.2378 (.1523)	.1189 (.0722)
DMAGE	.0647 (.0164)	.0356 (.0084)	.0724 (.0496)	.0180 (.0221)
DMEDU	.0318 (.0226)	.0091 (.0116)	.0499 (.0202)	.0226 (.0298)
DMHSZ	.1697 (.0245)	.1308 (.0124)	.1466 (.1787)	-.2017 (.0327)
PPBF	-.0032 (.0023)	-.0006 (.0012)	-.0047 (.0019)	-.0013 (.0032)
PPPL	.0081 (.0039)	.0036 (.0020)	.0100 (.0058)	-.0020 (.0053)
PPPK	-.0013 (.0018)	-.0013 (.0009)	-.0006 (.0022)	.0037 (.0024)

Table 6.14 Continued

Variables	Tobit	First-hurdle Dominance (Two-stage Estimator)		Complete Dominance
		Probit	Consumption	Consumption
TDMFEM2	-.1720	-.0635	-.2292	-.1340
	(.0426)	(.0218)	(.0931)	(.0553)
DTFEM2	.3002	.1541	.3554	.0058
	(.0438)	(.0226)	(.2048)	(.0567)
NDMREG2	-.2462	-.1334	-.2843	.0158
	(.0561)	(.0287)	(.1842)	(.0737)
NDMREG3	-.0156	-.0331	.0088	-.0133
	(.0527)	(.0271)	(.0577)	(.0703)
NDMREG4	-.1299	-.0951	-.1333	.0687
	(.0609)	(.0313)	(.1345)	(.0780)
WAVE	.0006	.0002	.0007	.0005
	(.0003)	(.0002)	(.0004)	(.0005)
SIGMA	2.1999		3.1301[b]	
	(.0197)		(2.0685)	
RHO				
-LOG L	23381.9	24497.6		24498.7

[a] Asymptotic standard errors are shown in parentheses below the parameter estimates.

[c] The variable is inverse mill's ratio. The coefficient is a multiplication of correlation coefficient and standard deviation of the disturbance term.

Table 6.15 LR Test Results for the Significance of Health Concerns in the First-hurdle Dominance Model for Fish

Models	-Log Likelihood Values	Test Statistics
Unrestricted	24497.6	
Restricted (i)	24502.5	$\chi^2_{df=4}$ = 9.8
Restricted (ii)	24501.3	$\chi^2_{df=2}$ = 7.4
Restricted (iii)	24498.8	$\chi^2_{df=2}$ = 1.6

[a] the log likelihood values are from Heckman's two-stage estimator. Critical values at $\alpha=0.05$ with degrees of freedom equal to four and two are 9.49 and 5.99 respectively.

[b] Restriction (i) stands for zero coefficients of PC1 and PC2 in both stages, restriction (ii) for zero coefficients of the two principal components only in participation equation, and (iii) for zero coefficients only in consumption equation.

Simulation Analyses

The preceding section focused on the economic significances of the directions of the impacts of the attitudinal, sociodemographic, and economic variables on the decisions of whether to participate and, given the participation, on the per capita servings of the five meat categories. Tests of statistical significance of their impacts were shown. The nature of the discussion remained qualitative. This section turns to the quantitative aspects of the empirical analysis, concentrating on the beef models. Namely, the magnitudes of the parameter estimates are directly used to simulate the responses of the per capita beef servings to predetermined variations in selected variables. Refer to Table 3.1 for detailed definitions of variables used in this section.

Maximum likelihood estimates of the first-hurdle dominance(sample selection) model are used for the simulation analyses. Since the model is composed of two stages, the simulation can be carried out using the two equations from each stage. In the first stage the variations in the probabilities of being consumers may be simulated, and then restricting the analysis to the beef consumers, the numbers of the per capita consumption frequency are simulated. Since the coefficients of the probit equation do not directly transform the independent variables into the observed(0/1) dependent variable, the parameter estimates need to be properly modified to reflect marginal effect of a unit change in selected independent variables. Regarding the first stage simulation, it could be more intuitive to show the levels of probabilities of becoming consumers rather than marginal changes in the probabilities related to predetermined changes in selected explanatory variables. Hence, the first stage simulation uses estimated parameters from the probit part instead of modified parameters.

The simulation procedures will visualize the patterns and ranges of the changes in the probabilities of being consumers and in the number of the beef servings per household members. Since linearity was assumed for the relationships between the per capita beef servings and most explanatory variables, the patterns of the responses are also linear, with advertising expenditures being the only exception. The simulations can provide useful informations for the design of industry marketing strategies or for public policy decision-makings.

In the second part of this section, conceptual linkage between prices and advertising expenditures will be shown graphically. Subsequently, based on the conceptual linkage, shadow value of advertising expenditures in terms of the marginal changes of beef prices will be derived with simple calculations. The derivation will elucidate the pattern of the positive implicit impact of advertising expenditures upon beef prices.

Selected variables for the simulation analysis include indexes of health concerns, beef checkoff expenditures, beef prices, and demographic variables(market size, age of female head, household size, and education of female head). Period between 1991 and 1993(CK3) and the West(NDMREG4) region were selected for simulation purposes. While NDMREG4 is chosen arbitrarily, the selection of CK3 is to reflect more recent environments in household beef consumption decisions. Other variables not simulated will remain fixed at their sample means. Note that since the model is linear in all variables except the checkoff expenditures, the assumptions used with certain fixed values(e.g. region, time, etc) do not change the response rate. Only the absolute number of servings will rise or fall depending on the assumed values for the variables not being simulated.

Simulations over Health Concerns

The scale of attitudes about fats and cholesterol were allowed to simultaneously vary from "completely agree" to " disagree mostly" in the derivations of principal components for health related variables. The scales about additives and preservatives were set at "neither agree nor disagree". Since the purpose of this section is to examine the impact of overall health concern rather than specific issues of health concern on beef consumption, this is a legitimate way of conducting simulations. Also, scaling responses to fats and cholesterol were correlated. Hence, it is reasonable to show the aggregate response with both scaled at the same time. Note that "completely agree" implies that the respondents are very much concerned.

Figure 6.1 illustrates the impact of health concerns on the probabilities of becoming consumers. The shift in the scale of health index from "completely agree" to "disagree mostly" increased the probability of being consumers approximately from 82 to 87 percent. Thus, the households, who are not concerned about the consequences of the intake of fats and cholesterol at all, would participate in the beef market 5 percent more likely than those who are very concerned about .

Figure 6.2 demonstrates the responses of consumers to health concerns given the consumption level is positive. It shows that, in comparison to the 4.33 per capita servings in two weeks when the households are strongly concerned about health issues, frequencies increase to over 4.75 per capita servings when they are completely unconcerned. The gain in servings across health concerns translates into approximately a 11.2 percent increase when households show less concern for fats and cholesterol.

Simulations over Price and Beef Checkoff Efforts

Retail beef price was allowed to change from $2.00 to $3.20 at each of the three advertising expenditure levels;$0, $6, and $12 millions, holding other variables fixed at their sample means or base discrete value. The parallel shifts in the per capita servings schedules in Figure 6.3 are caused by higher advertising expenditures. For example, an increase in beef checkoff efforts from $0 to $12 million results in 0.6 more servings. At $6 million beef checkoff efforts, the per capita servings frequency corresponding to price $2.00 is 3.9. When price rises to $3.20, the servings drops to 3.1, representing a 20 percent decline.

Figure 6.4 illustrates how consumers beef servings frequency responded to beef checkoff efforts at predetermined price levels of $2.35 and $3.20. The simulated lines show that the response function is nonlinear and that the number of servings increases at a declining rate. Note that this simulation was only for those who are participating in the beef market. The impact of beef checkoff efforts on the probit part, that is, on the decision whether or not to participate, is visualized in Figure 6.5. The simulation is shown at four different beef price levels; $2.00, $2.40, $2.80, and $3.20. Assuming zero advertising expenditures, a major price drop from $3.20 to $2.00 increases the probability of being beef consumers from 77 percent to 85 percent. While this price change is extreme, it does illustrate the range of potential changes in servings. Fixing beef price at $2.40, the probability of being consumers increases from 82.1 to 87.1 percent as checkoff expenditures rise from zero to $14 millions.

The marginal responses shown in Figure 6.5 clearly demonstrate that additional money spent in promoting beef consumption has a positive but marginally declining impact on servings per household member. The initial $1 million generated distinguishable responses, occupying nearly 35 percent of the total increases in per capita servings up to $15 million expenditures. After approximately the point of $4 million, the marginal responses remain fairly stable, not quickly dropping off. Obviously, the marginal response is limited by our nonlinear form used and caution must be exercised when simulating too far beyond the data range.

Simulations over Demographic Variables

Figures 6.7, 9, 11, 13 show the probabilities of being beef consumers related to selected demographic variables. The positive impact of household size on the probability is quite notable in that the probability of being beef consumers in the households of 5+ members is almost 99.8 percent in a two week period, compared to 84 percent of 1 member household. The other figures are shown without explanations. It was shown earlier that market size, education and age of female head were negatively associated with the per capita beef servings frequency, while household size had positive impact. Figures 6.8, 10, 12, and 14 show the magnitudes of the changes in beef servings to predetermined changes in the above listed demographic variables. Consumers located in rural areas serve beef 23 percent more frequently than those in metropolitan areas. College graduates were 33 percent less likely to eat beef than those who did not finish high school. Consumers in a household size of 5+ members serve beef 6.4 frequency, which is almost 70 percent higher than the frequency of servings of those in a household of 1 member size. As shown in Figure 6.9, the age of female head did not make a measurable difference in the per capita beef servings(consumers with female heads older than 65 years serve 2.89, and those with ones under 35 years consuming 2.94 frequency). As one scenario using the above simulation

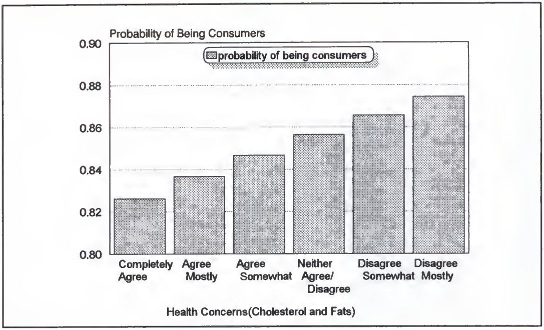

Figure 6.1 Estimated Response in the Probabilities of Becoming Consumers in a Two Week Period as Related to a Likert Scale of Concerns about Fats and Cholesterol

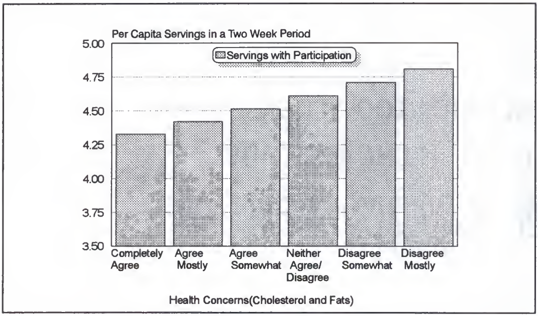

Figure 6.2 Estimated Response in the Per Capita Servings in a Two Week Period as Related to a Likert Scale of Concerns about Fats and Cholesterol

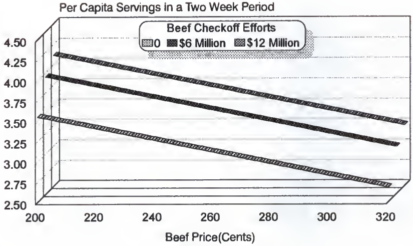

Figure 6.3 Estimated Responses in the Per Capita Servings as Related to Retail Beef Prices(cents per lb.) at Three Different Levels of Advertising Expenditures

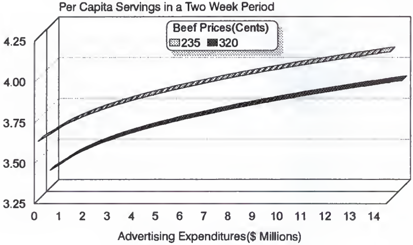

Figure 6.4 Estimated Responses in the Per Capita Servings in a Two Week Period as Related to Beef Checkoff Efforts

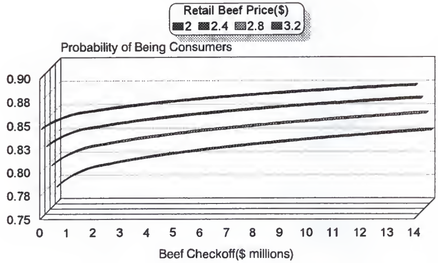

Figure 6.5 Estimated Responses in the Probabilities of Becoming Consumers as Related to Beef Checkoff Efforts

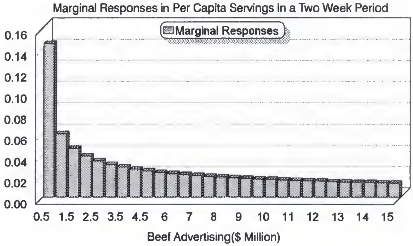

Figure 6.6 Estimated Marginal Response in the Per Capita Servings in a Two Week Period as Related to Beef Checkoff Efforts

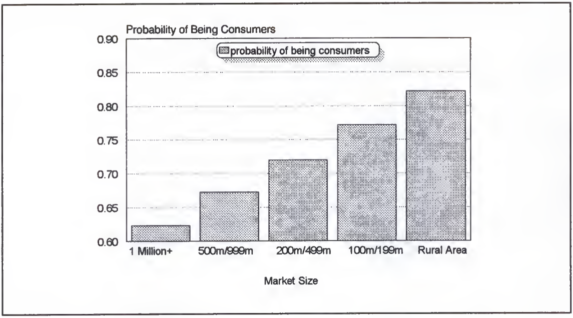

Figure 6.7 Estimated Response in the Probability of Being Consumers as Related to Market Size

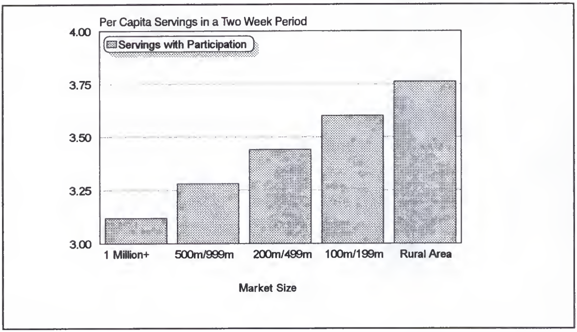

Figure 6.8 Estimated Response in the Per Capita Servings in a Two Week Period as Related to Market Size

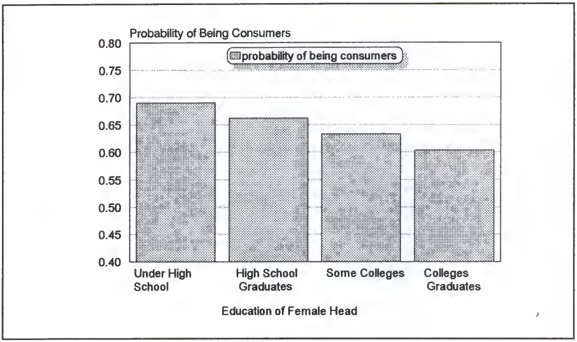

Figure 6.9 Estimated Response in the Probability of Being Consumer as Related to Education of Female Head

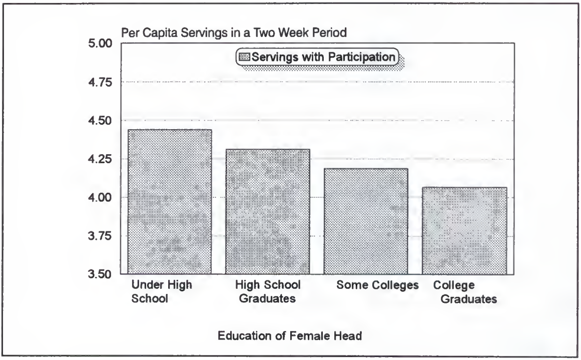

Figure 6.10 Estimated Response in the Per Capita Servings in a Two Week Period as Related to Education of Female Head

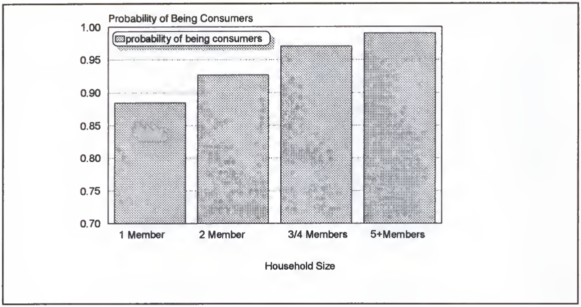

Figure 6.11 Estimated Response in the Probability of Being Consumers as Related to Household Size

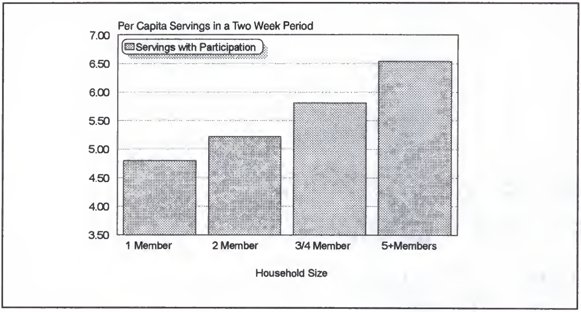

Figure 6.12 Estimated Response in the Per Capita Servings in a Two Week Period as Related to Household Size

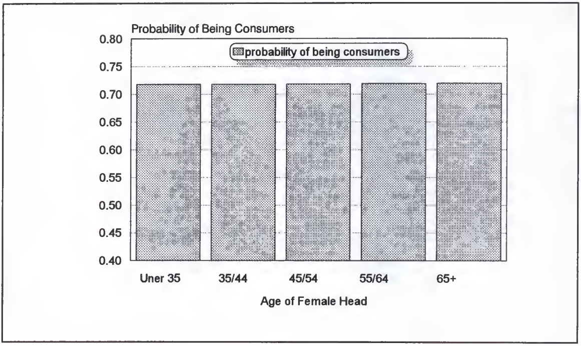

Figure 6.13 Estimated Response in the Probability of Being Consumers as Related to Age of Female Head

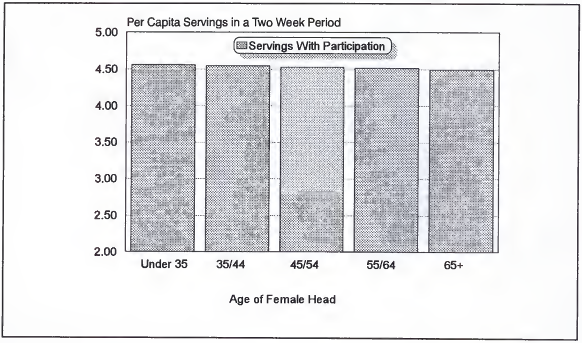

Figure 6.14 Estimated Response in the Per Capita Servings in a Two Week Period as Related to Age of Female Head

results, college graduate consumers in small-sized households located in metropolitan areas show the lowest serving level on a servings per household member basis.

Calculation of the Implicit Value of the Advertising Expenditures

Concerning the impact of beef checkoff expenditures, one of the most important questions is whether the checkoff programs are contributing to beef producer revenues enough to cover the program costs(expenditures). Simply stated, the industry needs to determine whether the revenue gains exceed the checkoff expenditures or assessments. In order to calculate the gains, information about price increases is required. If a price-dependent demand model were used, the direct impact of checkoff expenditures on price could be derived. Since this research used a traditional serving-dependent servings model, several steps are needed to derive the implicit linkage between price and checkoff expenditures. The following procedures explain the steps.

Using the estimated coefficients of beef prices and advertising expenditures reported in the preceding section, it is possible to measure the range of beef price increases that could occur to just hold the per capita beef consumption frequency fixed for different beef advertising levels. The potential increases in the beef price implicitly represent the underlying value of the advertising given its upward impacts on the per capita beef servings. Conceptual models are graphically developed below to illustrate this concept, before actual simulations are performed.

Figure 6.15 depicts the implicit linkage between prices and advertising expenditures. The right hand side graph in figure 6.15 illustrates the hypothetical upward shifts in the number of beef servings, and the matching increases in prices when the number of beef servings is constrained to remain

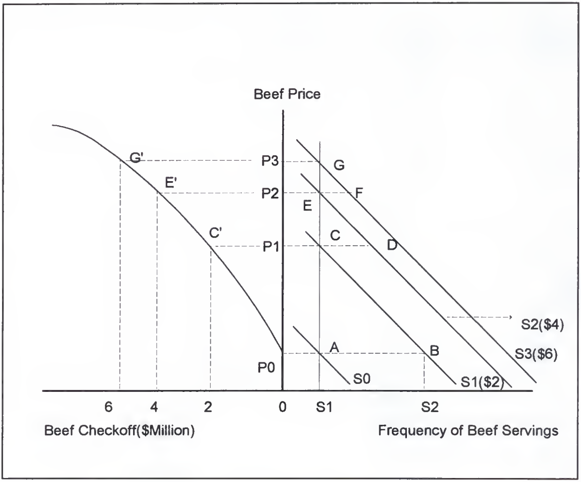

Figure 6.15 Hypothetical Implicit Linkage between Beef Price and Advertising Expenditures

at S1. It shows that the implicit impacts of advertising expenditures on prices get smaller because of the declining marginal advertising effects captured with the square root of the advertising expenditures in the model. For example, with two million dollars of expenditures, beef servings increase to point B with the fixed price P0. If beef servings are restricted at S1, then price rises to P1. In similar ways, the next increase by two million dollars causes price to rise to P2 and then to P3 with another two million dollar increase. It is assumed that servings remain fixed at S1 for each increase. Along the vertical line, the magnitudes of the rises in prices become smaller.

The points C, E, and G are reproduced in the direct mapping of the prices and advertising expenditures as C', E', and G' in the left side of Figure 6.15. The shape of the curve connecting points C', E', and G' is concave from below, as designed. The underlying hypothesis here is that larger advertising expenditures raise the value of beef at a declining rate. The simulated advertising expenditures can show the range of the change in the beef prices given the response function as illustrated in this figure.

Implicit relationship between advertising expenditures and beef prices can also be explored in terms of the marginal changes in prices related to increases in advertising expenditures. Then, the vertical line in Figure 6.15 will represent marginal changes in beef prices, which can be termed shadow price(value) of advertising expenditures. The shadow value can be derived with simple calculations. First, the per capita beef servings are expressed as linear functions of beef prices, square root of advertising expenditures, and others.

$$S = \beta_0 X + \beta_1 P + \beta_2 \sqrt{AD} \tag{6-2}$$

where, S = *number of the per capita beef servings,*
X = *a mean vector of other variables*
P = *beef price*
AD = *per capita advertising expenditures*
β_0, β_1, *and* β_2 *are estimated parameters*

Taking the total differentials with respect to beef price and advertising expenditures gives equation (6-3),

$$dS = \beta_1 dP + \frac{B_2}{2\sqrt{AD}} dAD \tag{6-3}$$

Setting the changes in the per capita beef servings equal to zero, and rearranging terms produces the simple derivative illustrating the changes in prices associated with changes in the advertising expenditures.

$$(6\text{-}4) \qquad dP = -\left(\frac{\beta_2}{2\,\beta_1\sqrt{AD}}\right) dAD \qquad \textit{where} \quad \beta_1 \textit{ is negative and } \beta_2 \textit{ is positive}$$

The right hand side of the equation (6-4) is always positive, confirming the implicit positive value of advertising expenditures. Since AD enters the model as $1/\sqrt{AD}$, it is clear that the impact of increasing advertising declines with larger expenditure levels. Ultimately as advertising approaches infinity, the marginal change in price goes to zero.

Using equation 6-4, marginal changes in beef price can be calculated at various levels of advertising expenditures. Figure 6.16 illustrates the calculated accumulative marginal changes in beef prices at retail, boxed beef, and live weight market levels when advertising expenditures vary from $0.5 to $14.5 million. Boxed beef refers to the primary cuts which packers break from animal carcass at the slaughter houses(Ward, 1993). The linkage between retail and boxed beef prices is approximated with a weight of 0.438 and boxed beef to live weight with the adjustment coefficient of 0.634. These weights are based on the average percent of each market price relative to the next level. Then a change at retail can be approximated for the live weight market level.

At the retail level, increases in beef checkoff efforts from $0.5 to $14.5 million leads to a 50 cents rise in beef prices to hold servings constant, which could be considered the implicit calculated value per consumer of advertising expenditures. The shape of the curves is similar to what Ward(1993, 1994) has found in his beef checkoff program evaluation analysis. Since a price-dependent demand model was fitted in that analysis, explicit linkage between price and advertising expenditures could be derived.

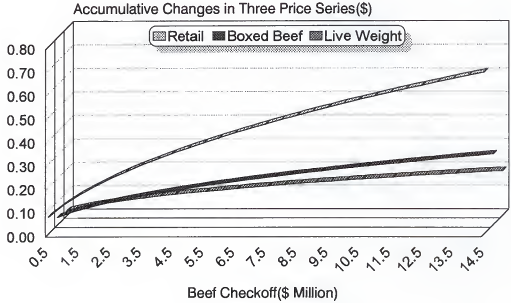

Figure 6.16 Calculated Cumulative Changes in Retail, Boxed Beef, and Live Weight Prices in Responses to Beef Checkoff Efforts

CHAPTER 7
IMPLICATIONS FOR INDUSTRY MARKETING STRATEGIES AND PUBLIC POLICIES

Overview

The purpose of this chapter is to discuss the implications of the empirical results of the preceding Chapter for beef industry marketing strategies and public policies. There are a couple of points that need to be addressed concerning the properties of the NPD database before the implications of the empirical results are discussed.

One of the major motivations of this study was the sharp decline in beef consumption over the last two decades. Since time-series information was not readily available for the suspected sources of the decline in beef consumption, an alternative cross-sectional approach using the NPD database was taken to investigate whether the suspected sources had a measurable impact on beef consumption. For example, variations in consumers' attitudes regarding health concerns across households over time were utilized. Hence, it was not intrinsically appropriate to use the results of this study to attempt to explain the temporal issues of the changes in beef consumption. However, if the suspected sources had significant impact on beef consumption cross-sectionally, it can be an indirect, still strong evidence that they might have significantly contributed to the decline of beef consumption over time. While some discussions of industry marketing strategies and public policies require only the straightforward cross-sectional results, other part of the discussion will need to take cross-sectional results as evidences over time.

The second point is linked to how the dependent variable in this study is defined. Unlike traditional expenditure or volume(quantity) data, it was defined as the number of servings in a two week period. As a result, the findings of this research have no direct bearing on the household budget shares or on actual market. Still, the NPD frequency data has no drawbacks in analyzing the factors that affect consumption behavior.

While this study addresses economic shock only from the demand side, the next section will be devoted to the discussion to major changes in other parts of the beef market such as producer or processing sides. For example, there have been substantial structural changes in the beef packing industry over the last twenty years. Specifically, the concentration ratio in the boxed beef industry increased dramatically in the 1980s. It would be informative to discuss potential linkage between the consolidation and the sharp decline in beef consumption over the last twenty years.

Industry marketing strategies will be discussed in the third section. Primarily the estimated results about health concerns, household characteristics, and beef checkoff efforts will provide relevant information to determine whether adjustments in the current production, processing, and retailing sectors are necessary. That is, every stage in the vertical channel of the beef industry needs to be concerned about the change, if any, in consumption environments to regain market shares lost to competing goods.

The fourth section deals with the public policy issues arising from any potential changes in beef consumption environment. The primary function of a market is to coordinate supply and demand by detecting and transmitting new information about market conditions to consumers and producers. Since markets are not perfect in achieving that goal, especially with agricultural products, institutions may need to intervene in the market. While government interventions in the beef industy are diverse, ranging from regulatory to market facilitating roles, what concerns this research is grading policies. If necessary, the grading policies can be changed to better serve the coordination in the beef market in response to the increased health awareness of consumers.

The Beef Industry in Brief

Even though the declining beef consumption trend over the last two decades has been the single most important phenomenon in beef industry, there have been other notable changes in other parts of the industry. For example, the boxed beef technology introduced in the 1960s became the dominant form by 1980, largely supplanting carcass beef by the late 1980s. The introduction of boxing technology stimulated the beef packing industry to be differentiated into two subsets: first, beef packers exclusively processing U.S. Choice, yield grade 2 and 3, fed steer and heifer into boxed beef; and others that specialize in processing low quality cattle such as culled cows and bulls. Another major change is the increased concentration ratio in the beef packing segment of the industry. The four-firm concentration ratio in boxed beef production jumped from 51 percent in 1979 to 79 percent in 1988(Purcell, 1990).

These technological and structural changes in the beef packing industry might have been associated with the decline in beef consumption. In fact, Purcell argues that the consolidation in the beef packing industry is a result of the structural change in meat demand. Apparent effects of the decline in beef consumption were decreases in real prices and the continuation of herd liquidation that started in 1975 from over 132 million herd into 1990s with the herd under 100 million. As a result, the beef packing industry had tremendous pressures to be cost effective to survive. Connor ascribes the changes in concentration ratio to the introduction of boxing technology. While it is not easy to rigourously identify the causes of the structural changes in the beef packing industry, the potential impacts of the consolidation on the beef market have important implications for public policies. The consolidation may allow the industry to increase efficiency by achieving economies of scale(Chicago School, NEIO), or deteriorate allocative efficiency with oligopolistic pricing behavior(Bainsian SCP Paradigm). It remains to be seen whether the consolidation is conducive to responding to changes in consumer preferences.

Implications for Industry Marketing strategies

Major variable groups that this section is concerned about include attitudinal scale about health concern, demographics, and beef checkoff programs. Unfortunately, since convenience variable was not available for this study, formal inferences regarding the role of convenience on beef consumption could not be made. Careful interpretation of time trend and selected demographic variables, however, might shed some lights on the role of a convenience variable.

The various censored regression models in the preceding chapters consistently showed that health concerns(fat and cholesterol) have significant negative impacts on the beef servings. Its impact was positive across white meat and fish. The contrasting result confirms that consumers perceived beef as high in fat and cholesterol, and reduced beef consumption, part of which might have been switched to white meat and fish out of health concerns. Then, a clear implication from these results is that the beef industry needs to address the health issues. There can be several ways of responding to the increased health concerns of consumers.

First, the industry needs to produce leaner beef. To identify exactly what consumers desire, knowledge of what consumers mean by "leaner" is essential. Yankelovich's study(1986) provides some insights regarding the perception of leanness to consumers. He found that only external and intermuscular fats are considered bad, implying that marbling(intramuscular fats) is a positive attribute. In fact, in the late 80s, most retailers adopted one-quarter inch of external fat thickness, giving up one inch standard. Also, reductions have been made in the gross fatness of market livestock. Although these are indicators that the industry is heading in the right direction, it seems that more drastic measures are needed.

Once leaner beef is produced, product differentiation based on leanness can be an effective strategy of addressing the health issues. Branding and labeling are required to help the differentiated products to effectively compete in the market. They will assist consumers in recognizing and appreciating the differentiated products. That is, the beef industry needs to focus more on consumer-oriented marketing rather than the traditional commodity approach. To make the products differentiation strategy possible, each vertical channel in the beef industry needs to be well coordinated.

A closely related issue is whether consumers are willing to pay more for the leaner, that is, differentiated and possibly branded beef. Menkhaus et al.(1988) provides three reasons of higher costs in producing leaner beef: 1) decreased use of concentrates and increased use of roughage where more feed per pound of gain is required; 2) higher cost of maintaining cattle for longer periods of time to ensure a year-round supply of beef; 3) lower proportions of the live weight as carcass weight because of decreased fat. Using hedonic price functions, Unnevehr and Bard(1993) found that consumers clearly value reductions in the external fat on almost all beef table cuts and reductions in intermuscular fat for chuck and round cuts.

Additional and effective efforts in dealing with the health issues can be made through beef checkoff programs, which started nationally in 1986. The beef checkoff programs have already been engaged in coping with health issues. For example, research sponsored by the checkoff programs has been used to help prove that beef is leaner than many consumers believe(Forker and Ward, 1993). Besides the research, activities of the checkoff programs include consumer information, education, advertising, industry feedback, and food service and retail promotion. Those activities can be approriate outlets to inform consumers of their efforts to meet changing preferences for beef.

Information on the impact of various demographic variables on beef consumption can be useful in segmenting consumers into smaller subgroups that are more homogeneous in those characteristics related to purchase decisions than the population as a whole. Those strategies are known "market segmentation". Once the market is segmented, the industry or firms can respond more effectively to the wants of perspective buyers. The effectiveness of product differentiation discussed above as a strategy of dealing with health issues can be greatly enhanced with adequate information on market segmentation. Even though the strategy of market segmentation has been popular and extremely effective in business marketing, it has not been part of agricultural marketing issues due to the rather homogeneous characteristics of most agricultural commodities. But with apparent major social, technological, and preference changes since 70s, consumer demand for more customized foods has increased, making the application of market segmentation strategy to food markets attractive.

It was shown earlier that education, age, and employment status of female head have negative impacts on beef consumption. Simulation analysis showed that households with college graduate female heads were 33 percent less likely to consume beef compared to those with non-high school graduates. Ward and Moon(1995) show that health concerns are higher among less educated. Hence, health concerns do not seem to explain the relatively lower consumption levels among college graduates. The percentage of college graduates was 41 with employed female, nearly twice as high as with unemployed female. With the result that the presence of employed female head had a negative impact on beef consumption, this might suggest that increased demand for convenience is one of the causes of the negative sign of the education variable. A consequent implication is the need to develop new products which possess the property of convenience. Such new products can be targeted to households with female heads who have jobs and have attented colleges.

As for the negative impact of market size, the preceding chapter gave two possible reasons: 1) rural areas' position to preserve traditional life styles; and 2) desire for variety of diet in big cities. Households located in cities of 1 million or more population size had 60 percent more college graduates and 45 percent more employed female heads than those in rural areas, suggesting demand for convenience as third potential reason of the negative sign of market size variable. Then, marketing strategies targeted to households in metropolitan areas need to address the convenience issue.

Significant negative impacts of time shift variables on the frequency of per capita beef servings, even after the inculsion of health concern variables, suggest difficult challenges to the beef industry. While it is not clearly known what is causing the negative trend, the two factors given in the preceding chapter seem to be reasonable alternatives. Then, an implication from these results is that the beef industry need not only to address health issues but also to respond to the desire for diversified diet and convenience. The negative trend in the NPD frequency model is consistent with the statistically significant declining trend in models using time-series market disappearances data(Ward, 1992). This consistency points to the usefulness of NPD frequency data as a companion source for analyzing beef consumption behavior.

Implications for Public Policy

Theoretically, the government intervenes in the market where prices fail to allocate resources in a way that satisfies the preferences of individuals and society. Significant part of government policies in the agricultural markets have been to deal with farm problems caused by inelastic price and income responses, and persistent disequilibrium between labor markets of farm and nonfarm sectors. In addition to these structural economic problems, social concerns about the availability of an adequate and reasonably priced food supply has fostered government involvement in some agricultural sectors.

Along with those structural and social concerns about agriculture, the scope of marketing regulations for consumer protection and efficient market development in the food industry has increased over the years. For example, while antitrust laws are to promote competition, thereby conducing technological development(dynamic efficiency), and protecting consumers from monopolistic pricing by the firms, facilitative market regulations such as grades and standardization, market information services, and meat inspection programs, are intended to increase the efficiency of food markets by reducing transaction costs. The government regulations need to adjust to changing technology and preferences of the society. Otherwise, resource allocation is distorted, and government failure can occur.

In particular, the grades and standardization contribute to improving pricing efficiency in two ways: 1)the use of grades gives consumers specific information with which to signal their preferences to producers, 2)the use of quality standards provide incentives for producers to adjust to changing consumer preferences. Grading services in the beef industry have evolved for over two-thirds of a century. There are two bases for beef grading: palatability or quality grades, and cutability or yield grade based on major retail cuts. In general, grade standards are designated for the carcass. Eight quality grade standards(prime, choice, select, standard, commercial, utility, cutter, and canner) and five yield grade standards(1 through 5 with 1 designating the highest cutability) are recognized. While quality grades are based on the composite of the fat factor of marbling, firmness, and maturity, major factors determining yield grade include external fat thickness, proportion of internal fat and carcass weight/size.

The significant impact of concerns about fat and cholesterol on beef consumption suggests an implication for the yield grading. Current standards for pricing boxed beef is one-inch trim for external fat. To encourage processors to further trim external fat, the market system must recognize these differences through price premiums and discounts.

CHAPTER 8
SUMMARY AND CONCLUSIONS

The primary objective of this study was to analyze the impacts of health-related attitudinal variables, demographics, and economic variables including beef checkoff programs on the number of per capita servings of beef, pork, chicken, turkey, and fish. NPD attitudinal survey data set was utilized to that end. Major findings for the beef model are briefly summarized as follows.

1) Health concerns had negative and statistically significant impacts on beef servings. Simulation analysis showed that per capita servings of beef stood at 4.3 times among those households strongly concerned about fats and cholesterol. In contrast, servings increased to the 4.8 times when the household are not concerned at all.
2) Market size, education and employment status of female head had negative impacts on the beef servings, while household size had a positive impact.
3) Beef checkoff programs had positive and statistically significant impacts on the per capita servings of beef. Simulation analysis showed that the number of per capita beef servings increase about 0.5 servings when beef advertising expenditures ranged from 0 to 15 million.
4) The same range of advertising expenditures implicitly brings about 50 cents rise in beef price.

Summary

Substantial changes in meat consumption pattern over the last two decades were a major motive for this study. There have been considerable debates in agricultural economics profession concerning whether variations in prices and income can rationalize the dramatic changes in meat consumption pattern. Most of structural change studies confirmed that utility function for meat was not stable over the last two decades. The confirmations warranted the use of attitudinal(psychological) variables to investigate the causes of the structural changes.

Conventional demand analyses have focused only on variations in prices and income to explain market consumption behavior over time assuming that preferences remain constant over the study period. Cross-sectional survey data from individual households has facilitated the analyses of demographic effects on households food consumption pattern. While inclusion of demographic variables was one of major extentions of neoclassical demand theory beyond economic variables, preference change, which is caused in most cases by unobservable psychological factors, could not be handled until some recent cross-sectional data set included attitudinal responses of households toward various attributes of products.

NPD data are one of the representative cases of containing attitudinal responses and facilitating preference change analyses. The National Panel Diary Group maintains a panel of consumers across the U.S. with the purpose of recording changes in consumption behavior and attitudes. The NPD keeps a continued survey of consumers who report mainly their concerns for various aspects of health and nutrition issues, and demographics along with the frequency of their meat servings in a two week period. Consumers generally rank their concerns on an ordering scale of six categories: completely agree,

agree mostly, agree somewhat, neither agree nor disagree, diagree somewhat, disagree mostly. For example, the scale is applied to a question such as "a person should be cautious about fat".

For many questions it is probable that responses are highly correlated. As an example, concerns for health effects of fats and cholesterol are highly correlated. In those situations where variables can be grouped, it may be more desirable to create an index variable representative of the information found within the group. Procedures such as principal components provides one avenue for creating an index from the highly correlated variables. In these cases the index rather than the actual variables may be included in the analysis. This study identified two groups of variables that were highly correlated: 1)health-related variables(NTFAT, NTCHL, NTADD, AND NTPRE), and 2)eating behavior variables(FDHOT, FDPIZ, FDLUN, FDTAC, AND FDFCH). The first two and three principal components from each group were included in the econometric analyses.

The frequency of meat servings contains both zero and positive numbers. Zero observations raise a problem in econometric modelling efforts. If there is convincing evidence that zero servings are representations of true optimal corner solutions to consumers' utility maximization problem, Tobit model is appropriate. However, in many cases of food consumption behavior, part of zero observations can be indications of not participating in the market. For example, vegetarians are expected to report zero servings of any kind of meat. In such cases, a Tobit model does not capture consumption behavior appropriately. Furthermore, while Tobit model theoretically can take negative values, we do not observe them because of censoring. Zero observations in consumption data are due not to censoring, but due to the decisions of individuals. Hence, Maddala(1992) suggests that a procedure is needed to model the decisions that produce the zero observations rather than using the Tobit model.

Double-hurdle model is one of the several ways of modelling the behavior generating zero observations. Participation and intensity of consumption are modelled in separate equations. Magnitudes and signs of the parameter sets can be different in the two equations. Double-hurdle models depict a situation in which consumers desire a positive amount of the good in question, but consuming the good depends not only on the intensity of that desire but also such factors as search, information and transaction costs. That is, zero observations may arise either because the desired change is not positive or because other factors inhibit carrying out changes which would be desired in their absence. In other words, double-hurdle models allow the existence of non-consumers under two circumstances: 1)a certain portion of the zero reports are optimal responses to economic conditions and 2)the remaining zeros being indications of discrete choices to not become consumers.

When participation decisions dominate consumption decisions, that is all of the zero observations are indicators of consumers not to participate in the market, first-hurdle dominance model, is appropriate. The stochastic structure of the first-hurdle dominance model corresponds to Heckman's sample selection model. It is composed of a probit part and truncated regression part and can be estimated by maximum likelihood techniques or by a two-stage estimator.

Considering that the dependent variable in the NPD data is defined as the number of servings of each meat category in a two week period and that two weeks should be long enough to consume meat at least once if the consumer is not a vegetarian, it is reasonable to judge that the zero servings reports are not associated with consumption decisions. The judgement points to the first-hurdle dominance model as the better model to fit the NPD frequency data.

In the beef model, the estimated first-hurdle dominance model showed that health concerns compositely had negative and statistically significant impacts on both the decisions whether or not to participate in the beef market and the intensity of consumption. The results are not surprising given that while the health concerns may make some consumers decide not to consider even participating in the beef market, they can reduce intensity of the beef servings for other consumers. Health concerns had negative and significant impacts on the both decisions in the pork model. The consistently significant negative impacts on the servings frequency across pork and beef support the expectation that health concerns have reduced the overall consumption of red meat. The reductions can come from both smaller numbers of consumers in the markets and curtailed consumption of existing consumers.

While health concerns had positive impacts on the servings of chicken, turkey, and fish, the impacts were not statistically significant in both stages of the first-hurdle dominance model for chicken. The health concerns had statistically significant impacts only in the decisions of whether or not to enter the markets in the first-hurdle dominance model for turkey and fish.

Market size had negative impact on the beef and pork servings, while having positive impacts on the servings of chicken and fish. In the turkey model, the market size had positive effect on the discrete decision of becoming a consumer or not, but had a negative impact on the intensity of the servings. Most of other demographic variables in the beef model had expected signs. Selected variables including health concerns were used to simulate and visualize the response patterns of the per capita servings.

While the impact of time trend variable was negative and statistically significant in the beef model, its impact on other meat categories was not statistically significant. The negative and significant time trend in the beef model suggest that there are factors other than health concerns, sociodemographics, and prices that may help explain the household beef servings over time. Growth in demands for convenience and diversified diet was considered as potential factors that can explain the negative time trend.

To evaluate the effect of beef checkoff programs on the number of beef servings, quarterly advertising expenditure data were brought into NPD database. Beef checkoff expenditures had positive and statistically significant impact on both stages of the first-hurdle dominance model.

The pattern of the impact of checkoff expenditures on the beef servings were visualized through simulation analyses. Since a primary goal of the checkoff programs was to increase the consumer demand for beef and consequently producers' incomes, it is important to calculate the gains to producers using the estimated parameter value of the advertising variable. To calculate the gains, information about price increases due to advertising expenditures is required. Using the methods described in Chapter 6, implicit linkage between advertising expenditures and beef prices was conceptually developed and then, simulation analysis was used to show the pattern of the linkage. The implicit linkage was also explored in terms of the marginal price changes related to increases in advertising expenditures. The marginal price changes were termed shadow values of advertising expenditures because they are manifestations of the impacts on beef market of advertising expenditures.

Overall, this study suggested alternative ways of analyzing meat demand in terms of data use and econometric modelling. The NPD data included attitudinal responses about product attributes, thereby facilitating preference change analyses. Also, the dependent variables were defined as the number of servings in a two week period. Most of demand studies have been based on market disappearance data for time-series analyses and expenditures in a certain period of time for cross-sectional analyses. Econometrically, two-step decision processes were used to model meat consumption behavior. First-hurdle dominance model, produced quite consistent results with expectations and previous time-series studies in terms of parameter signs.

APPENDIX A
A TSP FILE OF NPD VARIABLE NAMES AND DEFINITIONS

```
? TAPES INITIALLY ON TWO DISK FILES;

? EACH WILL BE READ AND THEN A TSP FILE CREATED;

? ID    = HOUSEHOLD ID;

? YR    = REPORTING YEAR (I.E., 84 - MARCH 84 TO FEBURARY 84);

? WAVE  = NPD WAVE NUMBER;

? DMHSZ = DEMOGRAPHIC HOUSE HOLD SIZE (1=1 MEMBER, 2=2 MEM, 3=3/4 MEM,;
?         4=5+ MEMBERS);

? DMMSZ = MARKET SIZE (1=1 MIL+, 2=500/999 MIL, 3=250/499 MIL,;
?          4=50/249 MIL, 5=RURAL);

? DMCHL = CHILDREN UNDER 18 YEARS (1=YES, 2=NO);

? DMFEM = EMPLOYMENT OF FEMALE HEAD (1=EMPLOYED, 2=NOT EMPLOYED);

? DMAGE = AGE OF FEMALE HEAD (1=<35, 2=35/44, 3=45/54, 4=55/64, 5=65+);

? DMEDU = EDUCATION OF FEMALE HEAD (1=NO HIGH S, 2=HIGH S, 3=SOME COLLEGE,;
?         4=COLLEGE GRADUATE);

? DMREG = CENSUS REGION (1=NE, 2=MA, 3=ECN, 4=WNC, 5=SA, 6=ESC, 7=WSC, ;
?         8=MTN, 9=PAC);

? DMINC = HOUSEHOLD INCOME (1=UNDER $10000, 2=10/19999, 3=20/29999,;
?         4=30/39999, 5=40/49999, 6=50/59999, 7=60/69999, 8=70/99999,;
?         9=100000+);

? DMPCI = PER CAPITA INCOME (IN THOUSANDS 06=$6000);

? DTCHL = CHILDREN ON DIET (YES OR NO);

? DTMAL = ADULT MALE ON DIET;

? DTFEM = ADULT FEMALE ON DIET;

? CNBEF = NUMBER OF HOUSEHOLD EATINGS IN 2 WEEKS -  BEEF;

? CNPOR = NUMBER OF HOUSEHOLD EATINGS IN 2 WEEKS -  PORK;

? CNHAM = NUMBER OF HOUSEHOLD EATINGS IN 2 WEEKS -  HAM;
? CNBAC = NUMBER OF HOUSEHOLD EATINGS IN 2 WEEKS -  BACON;

? CNOTH = NUMBER OF HOUSEHOLD EATINGS IN 2 WEEKS - OTHER RED MEAT;

? CNCHK = NUMBER OF HOUSEHOLD EATINGS IN 2 WEEKS - CHICKEN;

? CNTUR = NUMBER OF HOUSEHOLD EATINGS IN 2 WEEKS - TURKEY;

? CNPOL = NUMBER OF HOUSEHOLD EATINGS IN 2 WEEKS - OTHER POULTRY;

? CNFSH = NUMBER OF HOUSEHOLD EATINGS IN 2 WEEKS - FISH/SEAFOOD;

? CNCAN = NUMBER OF HOUSEHOLD EATINGS IN 2 WEEKS - CANNED SEAFOOD;

? CNPRO = NUMBER OF HOUSEHOLD EATINGS IN 2 WEEKS - PROCESSED MEATS;


? ORIGINAL ATTITUDINAL SURVEY SINCE 1984;

?  1=COMPLETELY AGREE, 2=AGREE MOSTLY, 3=AGREE SOMEWHAT, 4=NEITHER AGREE;
?    OR DISAGREE, 5=DISAGREE SOMEWHAT, 6=DISAGREE MOSTLY;

? ATSNK = AVOID SNACKING ENTIRELY;

? ATFRY = AVOID FRIED FOOD;

? ATFOR = AVOID FOREIGN FOOD;

? ATBAK = LIKE TO BAKE FREQUENTLY;

? ATLAB = CHECK LABELS FOR HARMFUL INGREDIENTS;

? ATDOC = DOCTORS GIVES ADVICE ON DIET;

? ATREG = IMPORTANCE TO EAT REGULAR MEALS;

? ATWGT = OVERWEIGHT ISN'T ATTRACTIVE;

? ATSWM = LOVE TO SWIM;

? ATCAL = CONSCIOUS OF CALORIES;

? ATLBS = LIKE TO LOSE 20 POUNDS;


? FOOD AND BEVERAGE HABITS;

? 1=ALWAYS ENCOURAGE, 2=ALMOST ALWAYS ENCOURAGE, 3=SOMETIMES ENCOURAGE,
? 4=NEITHER, 5=SOMETIMES DISCOURAGE, 6=ALMOST ALWAYS DISCOURAGE;
? FDHOT = HOT DOG SANDWICH;
? FDCER = GRANOLA CEREAL;
? FDBER = BEER;
? FDWIN = WINE;
? FDMLK = WHOLE MILK;
? FDBRD = WHITE BREAD;
? FDRIC = RICE;
? FDSKM = SKIM/LOW FAT MILK;
? FDMAR = MARGARINE;
? FDCOF = CAFFEINATED COFFEE;
? FDSWT = PRE SWEETENED CEREAL;
? FDTUR = TURKEY;
? FDPIZ = PIZZA;
? FDLUN = LUNCHMEAT;
? FDFFR = FRENCH FRIES;
? FDTAC = TACOS;
? FDFCH = FRIED CHICKEN;

? NUTRITIONAL QUESTIONS AGREE OR DISAGREE;
? NTKNO = KNOW MORE THAN MOST;
? NTPLN = PLAN NUTRITIOUS MEALS;
? NTCHL = CHILDREN SHOULD NOT EAT SWEETS;
? NTVIT = VITAMINS RECOMMENDED BY PHYSICIAN;
? NTING = FOOD SHOULD HAVE BODY BUILDING INGREDIENTS;
? NTFRU = ALWAYS KEEP SOME FRUIT AROUND;
? NTSUG = A PERSON SHOULD BE CAUTIOUS ABOUT - SUGAR;
? NTCHL = A PERSON SHOULD BE CAUTIOUS ABOUT - CHOLESTEROL;
? NTADD = A PERSON SHOULD BE CAUTIOUS ABOUT - ADDITIVES;

? NTFAT = A PERSON SHOULD BE CAUTIOUS ABOUT - FATS;

? NTSAL = A PERSON SHOULD BE CAUTIOUS ABOUT - SALT;

? NTPRE = A PERSON SHOULD BE CAUTIOUS ABOUT - PRESERVATIVES;

? NTCAF = A PERSON SHOULD BE CAUTIOUS ABOUT - CAFFEINE;

? NTFRS = IMPORTANT FOR FOOD TO BE FRESH;

? NTCAN = DEPEND MOSTLY ON CAN FOOD;

? NTLOK = MOST IMPORTANT FOOD LOOKS, SMELLS, TASTES GOOD;

? NTBRN = BEST KNOWN BRANDS ARE HIGHEST QUALITY;

? NTTAS = EVERYTHING GOOD FOR YOU DOESN'T TASTE GOOD;


? NEW ATTITUDE SURVEY SINCE 1990;

? 1=COMPLETELY AGREE, 2=AGREE MOSTLY, 3=AGREE SOMEWHAT, 4=NEITHER AGREE;
? OR DISAGREE, 5=DISAGREE SOMEWHAT, 6=DISAGREE MOSTLY, 7=DISAGREE
  COMPLETLY;

? GAMEL = MEALS PLANNED TO BE NUTRITIOUS;

? GAFAT = TRYING TO CONSUME LESS FAT;

? GACHO = TRYING TO CONSUME LESS CHOLESTEROL;

? GATAS = TASTE MORE IMPORTANT THAN NUTRITION;

? GABAK = LIKE TO BAK FREQUENTLY;

? NVSOP = NUTRITIONAL VALUE OF SOUP;

? NVPEA = NUTRITIONAL VALUE OF PEANUT BUTTER;

? NVBRD = NUTRITIONAL VALUE OF WHEAT BREAD;

? NVKET = NUTRITIONAL VALUE OF KETCHUP;

? NVOAT = NUTRITIONAL VALUE OF OATMEAL;


? FPLAB = FOOD PURCHASE FOR LABELS;

? FPRES = VISIT RESTAURANT MORE THAN MOST;
? FPFAS = TRY FAST FOOD PLACES;

? FPBRN = BEST KNOWN BRANDS ARE HIGHEST QUALITY;

? FPBUY = CHILDREN INFLUENCE BARNDS I BUY;

? FPCHH = CHILDREN (0=NOT REPORTED, 1=NO CHILDREN, 2=NO CHILDREN AT HOME;
          3=CHILDREN TOO YOUNG;

? BLANK;


? FOOD AND BEVERAGES ENCOURAGES/DISCOURAGES;

? 1=COMPLETELY AGREE, 2=AGREE MOSTLY, 3=AGREE SOMEWHAT, 4=NEITHER AGREE;
? OR DISAGREE, 5=DISAGREE SOMEWHAT, 6=DISAGREE MOSTLY, 7=DISAGREE
  COMPLETLY;

? FVSOF = DIET SOFT DRINKS;

? FVGRV = GRAVY;

? FVMLK = MILK;

? FVBUT = BUTTER;

? FVEQL = EQUAL;

? FVMAR = DIET MARGARINE;

? FVTUR = TURKEY;

? FVBAC = BACON;

? FVOAT = OATMEAL;

 ? PRCOV = FOOD PREPARATION CONVENIENCE;

? PRFRY = AVOID FRIED FOOD;

? PRSUG = PERSON SHOULD BE CAUTIOUS SERVING FOODS WITH - SUGAR;

? PRCHO = PERSON SHOULD BE CAUTIOUS SERVING FOODS WITH - CHOLESTEROL;

? PRFAT = PERSON SHOULD BE CAUTIOUS SERVING FOODS WITH - FATS;

? PRSAL = PERSON SHOULD BE CAUTIOUS SERVING FOODS WITH - SALT;

? PRSER = PERSON SHOULD BE CAUTIOUS SERVING FOODS WITH - PRESERVATIVES;

? PRCAF = PERSON SHOULD BE CAUTIOUS SERVING FOODS WITH - CAFFEINE;
```

APPENDIX B
TSP PROGRAMS AND DATABANK CONTENTS

TSP Programs

```
OPTIONS MEMORY=30;
TITLE 'BEEF CHECKOFF PROJECT: NPD DATA TAPES';
OPTIONS LINLIM=500 ;
LIST OLD1
ID  YR  WAVE   DMHSZ   DMMSZ   DMCHL  DMFEM  DMAGE  DMEDU   DMREG DMINC;
LIST OLD2
DMPCI  DTCHL  DTMAL  DTFEM  CNBEF  CNPOR  CNHAM  CNBAC  CNOTH CNCHK ;
LIST OLD3
CNTUR  CNPOL  CNFSH  CNCAN  CNPRO  ATSNK  ATFRY  ATFOR  ATBAK  ATLAB;
LIST OLD4
ATDOC  ATREG  ATWGT  ATSWM  ATCAL  ATLBS FDHOT  FDCER  FDBER  FDWIN ;
LIST OLD5
FDMLK FDBRD  FDRIC  FDSKM FDMAR  FDCOF  FDSWT  FDTUR  FDPIZ  FDLUN  FDFFR;
LIST OLD6
FDTAC  FDFCH NTKNO  NTPLN  NTCHL  NTVIT NTING  NTFRU  NTSUG  NTCHL;
LIST OLD7
NTADD  NTFAT  NTSAL  NTPRE  NTCAF  NTFRS  NTCAN  NTLOK  NTBRN  NTTAS ;

DBLIST 'C:\WMOON\NPD\BFN93#0'
       'C:\WMOON\NPD\BFN93#1'
       'C:\WMOON\NPD\BFN93#2'
       'C:\WMOON\NPD\BFN93#3'
       'C:\WMOON\NPD\BFN93#4'
       'C:\WMOON\NPD\BFWAVE93'
       'C:\WMOON\NPD\NPDPRC';

IN 'C:\WMOON\NPD\BFN93#0'
   'C:\WMOON\NPD\BFN93#1'
   'C:\WMOON\NPD\BFN93#2'
   'C:\WMOON\NPD\BFN93#3'
   'C:\WMOON\NPD\BFN93#4'
   'C:\WMOON\NPD\BFWAVE93'
   'C:\WMOON\NPD\NPDPRC';

?DEFINE NEW REGIONAL VARIABLES
NDMREG=(DMREG<=2)*1+((DMREG>2)&(DMREG<=4))*2+((DMREG>4)&(DMREG<=7))*3
        +(DMREG>7)*4;
DUMMY NDMREG;

?CREATE NEW DEPENDENT VARIABLES:NORMALIZED BY HOUSEHOLD SIZE
NCNBEF=CNBEF/DMHSZ;
```

```
NCNPOR=CNPOR/DMHSZ;
NCNCHK=CNCHK/DMHSZ;
NCNTUR=CNTUR/DMHSZ;
NCNFSH=CNFSH/DMHSZ;


?CREATE DEFLATED TOTAL ADVERTIZING EXPENDITURE
DTADV=TADV/IINX;
?CREATE PER CAPITA ADVERTIZING EXPENDITURE
PTADV=TADV/PPOP; ptadv=ptadv*10;

?CREATE PER CAPITA DEFLATED TOTAL ADVERTIZING EXPENDITURE
PDTADV=DTADV/PPOP; pdtadv=pdtadv*100;

?partition advertising expenditure into THREE GROUPS
Pptadv=(tadv<2)*1+((tadv>=2)&(TADV<7))*2+(TADV>=7)*3;
DUMMY PPTADV;

?CREATE MONTHLY ADVERTISING EXPENDITURE
MTADV=TADV/3;
MMTADV=(MTADV<1)*1+((MTADV>=1)&(MTADV<2))*2+(MTADV>=2)*3;
DUMMY MMTADV;

?PROVIDE DESCRIPTIVE STATISTICS OF SELECTED VARIABLES
proc mmoon;
msd ntpln;
endproc;
do II=1 to 6;
select(ntpln=II);
mmoon;
enddo;

PROC MOON;
MSD NCNBEF NCNPOR NCNCHK NCNTUR NCNFSH;
ENDPROC;
DO YR=1984 TO 1993;
SELECT(YEAR=YR);
MOON;
ENDDO;

?CREATE THREE INCOME CATEGORIES
NDMINC=(DMINC<=2)*1+((DMINC>2)&(DMINC<5))*2+(DMINC>=5)*3;
DUMMY NDMINC;

PRIN(NAME=PC, NCOM=4, FRAC=.95) NTFAT NTCHL NTADD NTPRE;
PRIN(NAME=BH, NCOM=5, FRAC=1.0) FDHOT FDPIZ FDLUN FDTAC FDFCH;

?CREATING A PERMANENT DATABASE FOR THE PRINCIPLE COMPONENTS
OUT 'C:\WMOON\NPD\BFPCOMP';
PRIN(NAME=PC, NCOM=4, FRAC=.95) NTFAT NTCHL NTADD NTPRE;
PRIN(NAME=BH, NCOM=5, FRAC=1.0) FDHOT FDPIZ FDLUN FDTAC FDFCH;
OUT;
DBLIST 'C:\WMOON\NPD\BFCOMP';
```

```
OUT 'C:\WMOON\NPD\EXERCISE';
READ(FILE='A:\MOON\HANN\TT2.DAT, FORMAT=FREE) YEAR GNPP COM TREND;
OUT;
DBLIST 'C:\WMOON\NPD\EXERCISE';

TDMFEM=(DMFEM<=1)*1+(DMFEM>1)*0;
DUMMY TDMFEM;
DUMMY DTFEM;
?CREATE TIME TREND
ck1=(year<1987);
ck2=((year>=1987)&(year<=1990));
ck3=(year>1990);

?TAKING SQUARE ROOT OF ADVERTISING VARIABLE
SQRTADV=SQRT(PTADV);

?ESTIMATION OF TOBIT MODELS
TOBIT NCNBEF C PC1 PC2  BH1 BH2 BH3  ATCAL NTLOK  DMMSZ NDMINC2 NDMINC3 DMAGE
      DMEDU DMHSZ PPBF PPPL PPPK TDMFEM2 DTFEM2  NDMREG2 NDMREG3 NDMREG4 ck2
      ck3 SQRTADV;
TOBIT NCNCHK C PC1 PC2  ATCAL NTLOK DMMSZ NDMINC2 NDMINC3 DMAGE DMEDU DMHSZ
      PPBF PPPL BH1 BH2 BH3 BH4 DMFEM2 DTFEM2 NTCAN
TOBIT NCNPOR C PC1 PC2  ATCAL NTLOK DMMSZ NDMINC2 NDMINC3 DMAGE DMEDU DMHSZ
      PPBF PPPK BH1 BH2 BH3 BH4 DMFEM2 DTFEM2
TOBIT NCNTUR C PC1 PC2   ATCAL NTLOK DMMSZ NDMINC2 NDMINC3 DMAGE DMEDU DMHSZ
      PPBF PPPL BH1 BH2 BH3 BH4 DMFEM2 DTFEM2
TOBIT NCNFSH C PC1 PC2  ATCAL NTLOK DMMSZ NDMINC2 NDMINC3 DMAGE DMEDU DMHSZ
      PPBF PPPL BH1 BH2 BH3 BH4 DMFEM2 DTFEM2

SET Y=NCNBEF;

?CREATING BINARY VARIABLE FROM Y
D=(Y<=0)*0+(Y>0)*1;

?ESTIMATION OF DOUBLE-HURDLE MODELS:
SMPL 1, 17109;
PROBIT  Y C
PC1 PC2 BH1 BH2 BH3 ATDOC ATREG ATCAL  NTKNO  NTPLN
NTLOK DMMSZ NDMINC2 NDMINC3 DMHSZ  DMAGE DMEDU  TDMFEM2 DTFEM2 PPBF
PPPL PPPK NDMREG2 NDMREG3 NDMREG4 CK2 CK3 SQRTADV;

SET SIG=@S;

?ESTIMATION OF TRUNCATED REGRESSION:SECOND STAGE OF SIMPLIFIED DOUBLE-HURDLE
 MODEL
SUPRES @SMPL;
SELECT Y>0;

FRML EQL LOGL=-LOG(SIG)+LNORM((Y-XB)/SIG)-LCNORM(XB/SIG);
FRML EQXB2 XB=B0 + B1*PC1 + B2*PC2 + B3*BH1 + B4*BH2 + B5*BH3 + B6*ATDOC +
B7*ATREG + B8*ATCAL  + B9*NTKNO  + B10*NTPLN + B11*NTLOK + B12*DMMSZ +
B13*NDMINC2 + B14*NDMINC3 + B15*DMHSZ  + B16*DMAGE + B17*DMEDU  + B18*TDMFEM2
+ B19*DTFEM2 + B20*PPBF + B21*PPPL + B22*PPPK + B23*NDMREG2 + B24*NDMREG3 +
B25*NDMREG4 + B26*CK2 + B27*CK3 + B28*SQRTADV;

EQSUB EQL EQXB2;
PARAM B0 B1 B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12 B13 B14 B15 B16 B17 B18 B19
B20 B21 B22 B23 B24 B25 B26 B27 B28 SIG;
ML(HITER=N, HCOV=NBW) EQL;

?JOINT ESTIMATION OF SIMPLIFIED DOUBLE-HURDLE MODEL
SMPL 1, 17109;
Y0=Y<=0; Y1=Y>0;
FRML EQ1 LOGL=Y0*LCNORM(-XE)
+ Y1*(-LOG(SIG)+LNORM((Y-XB)/SIG)+LCNORM(XE)-LCNORM(XB/SIG));

FRML EQXB1 XE=E0+E1*PC1 +E2*PC2 +E3*BH1 +E4*BH2 +E5*BH3 +E6*ATDOC
+E7*ATREG +E8*ATCAL  +E9*NTKNO  +E10*NTPLN+E11*NTLOK +E12*DMMSZ
+E13*NDMINC2 +E14*NDMINC3 +E15*DMHSZ  +E16*DMAGE +E17*DMEDU  +E18*TDMFEM2
+E19*DTFEM2 +E20*PPBF +E21*PPPL +E22*PPPK +E23*NDMREG2 +E24*NDMREG3
+E25*NDMREG4 +E26*CK2+E27*CK3+E28*SQRTADV;

EQSUB(NAME=SECDH) EQ1 EQXB2 EQXB1;

PARAM E0 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 E12 E13 E14 E15 E16 E17 E18
E19 E20 E21 E22 E23 E24 E25 E26 E27 E28
B0 B1 B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12 B13 B14 B15
B16 B17 B18 B19 B20 B21 B22 B23 B24 B25 B26 B27 B28 SIG;

?PROVIDING STARTING VALUES FOR THE FIRST AND SECOND STAGE
PROBIT D C
PC1 PC2
BH1 BH2 BH3
ATDOC ATREG ATCAL
NTKNO NTPLN NTLOK
DMMSZ NDMINC2 NDMINC3 DMHSZ DMAGE DMEDU TDMFEM2 DTFEM2
PPBF PPPL PPPK
NDMREG2 NDMREG3 NDMREG4 CK2 CK3 SQRTADV;
UNMAKE @COEF E0-E28;

OLSQ(ROBUST) Y C
PC1 PC2
BH1 BH2 BH3
ATDOC ATREG ATCAL
NTKNO NTPLN NTLOK
DMMSZ NDMINC2 NDMINC3 DMHSZ DMAGE DMEDU TDMFEM2 DTFEM2
PPBF PPPL PPPK
NDMREG2 NDMREG3 CK2 CK3 SQRTADV;

UNMAKE @COEF B0-B28;
SET SIG=@S;
ML(HCOV=NBW) SECDH;

?ESTIMATION OF ORIGINAL DOUBLE-HURDLE MODEL
FRML EQ2 LOGL=Y0*(LOG(1-CNORM(XE)*CNORM(XB/SIG))) + Y1*(LCNORM(XE)-LOG(SIG)+
LNORM((Y-XB)/SIG));
```

```
EQSUB(NAME=FRSDH) EQ2 EQXB2 EQXB1;
PARAM  E0 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 E12 E13 E14 E15 E16 E17 E18
E19 E20 E21 E22 E23 E24 E25 E26 E27 E28
B0 B1 B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12 B13 B14 B15
B16 B17 B18 B19 B20 B21 B22 B23 B24 B25 B26 B27 B28 SIG;

PROBIT D C
PC1 PC2
BH1 BH2 BH3
ATDOC ATREG ATCAL
NTKNO  NTPLN  NTLOK
DMMSZ NDMINC2 NDMINC3 DMHSZ DMAGE DMEDU TDMFEM2 DTFEM2
PPBF PPPL PPPK
NDMREG2 NDMREG3 NDMREG4 CK2 CK3 SQRTADV;

UNMAKE @COEF E0-E28;

SELECT Y>0;
OLSQ(ROBUST) Y C
PC1 PC2
BH1 BH2 BH3
ATDOC ATREG ATCAL
NTKNO  NTPLN  NTLOK
DMMSZ NDMINC2 NDMINC3 DMHSZ DMAGE DMEDU TDMFEM2 DTFEM2
PPBF PPPL PPPK
NDMREG2 NDMREG3 NDMREG4 CK2 CK3 SQRTADV;

UNMAKE @COEF B0-B28;
SET SIG=@S;

SMPL 1, 17109;
ML(MAXIT=50, HCOV=NBW) FRSDH;

?ESTIMATION OF DEPENDENT DOUBLE-HURDLE MODEL(ORIGINAL)
FRML EQ3 LOGL=Y0*(LCNORM(-XE)+LCNORM(-XB)-LOG(CNORM(-XE)*CNORM(-XB/SIG)
+NORM(-XE)*NORM(-XB)*(RHO+RHO**2*(-XE)*(-XB/SIG)/2+RHO**3*(-XE**2-1)
*(-XB**2-1)/6)))+Y1*(-LOG(SIG)+
LNORM((Y-XB)/SIG)+LCNORM((XE+RHO*(Y-XB)/SIG)*(1-RHO*RHO)**(-.5)));

EQSUB(NAME=DEPENDEN) EQ3 EQXB2 EQXB1;

PARAM E0 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 E12 E13 E14 E15 E16 E17 E18
E19 E20 E21 E22 E23 E24 E25 E26 E27 E28
B0 B1 B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12 B13 B14
B15 B16 B17 B18 B19 B20 B21 B22 B23 B24 B25 B26 B27 B28
SIG RHO;

PROBIT D C
PC1 PC2
BH1 BH2 BH3
ATDOC ATREG ATCAL
NTKNO  NTPLN  NTLOK
DMMSZ NDMINC2 NDMINC3 DMHSZ DMAGE DMEDU TDMFEM2 DTFEM2
```

```
PPBF PPPL PPPK
NDMREG2 NDMREG3 NDMREG4 CK2 CK3 SQRTADV;

UNMAKE @COEF E0-E28;
SELECT Y>0;
OLSQ Y C
PC1 PC2
BH1 BH2 BH3
ATDOC ATREG ATCAL
NTKNO  NTPLN  NTLOK
DMMSZ NDMINC2 NDMINC3 DMHSZ DMAGE DMEDU TDMFEM2 DTFEM2
PPBF PPPL PPPK
NDMREG2 NDMREG3 NDMREG4 CK2 CK3 SQRTADV;
UNMAKE @COEF B0-B26;
SET SIG=@S;
SMPL 1, 17109;
?ML(HCOV=NBW) DEPENDEN

?ESTIMATION OF THE FIRST-HURDLE DOMINANCE MODELS
?HECKMAN'S SAMPLE SELECTION MODEL:TWO-STAGE ESTIMATION(PROBIT AND OLS)

?CREATING BINARY VARIABLE FROM Y
D=(Y<=0)*0+(Y>0)*1;
PROBIT(MILLS=RMILLS) D C

BH1 BH2 BH3
ATDOC ATREG ATCAL
NTKNO  NTPLN  NTLOK
DMMSZ NDMINC2 NDMINC3 DMHSZ DMAGE DMEDU TDMFEM2 DTFEM2
PPBF PPPL PPPK
NDMREG2 NDMREG3 NDMREG4 ck2 ck3 SQRTADV;

SELECT Y>0;
OLSQ(ROBUST) Y C
BH1 BH2 BH3
ATDOC ATREG ATCAL
NTKNO  NTPLN  NTLOK
DMMSZ NDMINC2 NDMINC3 DMHSZ  DMAGE DMEDU  TDMFEM2 DTFEM2
PPBF PPPL PPPK
NDMREG2 NDMREG3 NDMREG4 ck2 ck3 SQRTADV RMILLS;

?COMPLETE DOMINANCE MODEL(DELETING THE INVERSE MILL'S RATIO VARIABLE)
OLSQ Y C
PC1 PC2
BH2 BH2 BH3
ATDOC ATREG ATCAL
NTKNO NTPLN NTLOK
DMMSZ NDMINC2 NDMINC3 DMHSZ DMAGE DMEDU TDMFEM2 DTFEM2
PPBF PPPL PPPK
NDMREG2 NDMREG3 NDMREG4 CK2 CK3 SQRTADV;

?MAXIMUM LIKELIHOOD ESTIMATION OF SAMPLE SELECTION MODEL
SMPL 1, 17109;
```

```
D=(Y<=0)*0+(Y>0)*1;

SAMPSEL(step=CEA, HITER=N, HCOV=NBW, MAXSQZ=30) D C  BH1 BH2 BH3
ATDOC ATREG ATCAL NTKNO NTPLN NTLOK
DMMSZ NDMINC2 NDMINC3 DMHSZ DMAGE DMEDU TDMFEM2 DTFEM2 PPBF PPPL PPPK
NDMREG2 NDMREG3 NDMREG4 CK2 CK3 SQRTADV | Y C  PC1 PC2 BH1 BH2 BH3 ATDOC
ATREG ATCAL NTKNO NTPLN NTLOK DMMSZ NDMINC2 NDMINC3 DMHSZ DMAGE DMEDU
TDMFEM2 DTFEM2 PPBF PPPL PPPK NDMREG2 NDMREG3 NDMREG4 CK2 CK3 SQRTADV;
END;

?RECOVERING THE PARAMETER ESTIMATES OF ORIGINAL VARIABLES
?MAKING CORRELATION MATRIX BETWEEN PCS AND ORIGINAL VARIABLES
?WHICH ARE FACTOR LOADINGS

?HEALTH VARIABLES
PRIN(NAME=PC, NCOM=4, FRAC=.95) NTFAT NTCHL NTADD NTPRE;
CORR PC1 PC2 NTFAT NTCHL NTADD NTPRE;

MSD PC1 PC2 NTFAT NTCHL NTADD NTPRE;
MAT CORRH=@CORR; MAT MSDH=@MSD;

?CALCULATING EIGENVALUES
?THE SUM OF SQUARED FACTOR LOADINGS ARE EQUAL TO EIGENVALUES
SET EVPC1=CORRH(3,1)**2+CORRH(4,1)**2+CORRH(5,1)**2+CORRH(6,1)**2;
SET EVPC2=CORRH(3,2)**2+CORRH(4,2)**2+CORRH(5,2)**2+CORRH(6,2)**2;

PRINT EVPC1 EVPC2;

?RECOVERING THE PARAMETER ESTIMATES OF THE ORIGINAL VARIABLES
SET BFAT=@COEF(2)*CORRH(3,1)/MSDH(3,2)/EVPC1+@COEF(3)*CORRH(3,2)/
MSDH(3,2)/EVPC2;
SET BCHL=@COEF(2)*CORRH(4,1)/MSDH(4,2)/EVPC1+@COEF(3)*CORRH(4,2)/
MSDH(4,2)/EVPC2;
SET BADD=@COEF(2)*CORRH(5,1)/MSDH(5,2)/EVPC1+@COEF(3)*CORRH(5,2)/
MSDH(5,2)/EVPC2;
SET BPRE=@COEF(2)*CORRH(6,1)/MSDH(6,2)/EVPC1+@COEF(3)*CORRH(6,2)/
MSDH(6,2)/EVPC2;
PRINT BFAT BCHL BADD BPRE;

?CALCULATING STANDARD ERRORS OF THE ORIGINAL VARIABLES
SET FATST=(@COEF(2)*CORRH(3,1)+@COEF(3)*CORRH(3,2))/
SQRT(((CORRH(3,1)**2)/EVPC1+(CORRH(3,2)**2)/EVPC2)*SIG);
SET CHLST=SQRT(((CORRH(4,1)**2)/EVPC1+(CORRH(4,2)**2)/EVPC2)*SIG);
SET ADDST=SQRT(((CORRH(5,1)**2)/EVPC1+(CORRH(5,2)**2)/EVPC2)*SIG);
SET PREST=SQRT(((CORRH(6,1)**2)/EVPC1+(CORRH(6,2)**2)/EVPC2)*SIG);
PRINT FATST CHLST ADDST PREST;

?EATING BEHAVIOR VARIABLES
PRIN(NAME=BH, NCOM=5, FRAC=1) FDHOT FDPIZ FDLUN FDTAC FDFCH;
CORR BH1 BH2 BH3 FDHOT FDPIZ FDLUN FDTAC FDFCH;
MSD BH1 BH2 BH3 FDHOT FDPIZ FDLUN FDTAC FDFCH;
MAT CORRB=@CORR;  MAT MSDB=@MSD;
```

```
?THE SUM OF SQUARED FACTOR LOADINGS ARE EQUAL TO CHARACTERISTIC ROOT
SET EVBH1=CORRB(4,1)**2+CORRB(5,1)**2+CORRB(6,1)**2+CORRB(7,1)**2+
CORRB(8,1)**2;
SET EVBH2=CORRB(4,2)**2+CORRB(5,2)**2+CORRB(6,2)**2+CORRB(7,2)**2+
CORRB(8,2)**2;
SET EVBH3=CORRB(4,3)**2+CORRB(5,3)**2+CORRB(6,3)**2+CORRB(7,3)**2+
CORRB(8,3)**2;
?RECOVERING THE PARAMETER ESTIMATES OF THE ORIGINAL VARIABLES
SET BHOT=@COEF(4)*CORRB(4,1)/MSDB(4,2)/EVBH1+@COEF(5)*CORRB(4,2)/
MSDB(4,2)/EVBH2+@COEF(6)*CORRB(4,3)/MSDB(4,2)/EVBH3;
SET BPIZ=@COEF(4)*CORRB(5,1)/MSDB(5,2)/EVBH1+@COEF(5)*CORRB(5,2)/
MSDB(5,2)/EVBH2+@COEF(6)*CORRB(5,3)/MSDB(5,2)/EVBH3;
SET BLUN=@COEF(4)*CORRB(6,1)/MSDB(6,2)/EVBH1+@COEF(5)*CORRB(6,2)/
MSDB(6,2)/EVBH2+@COEF(6)*CORRB(6,3)/MSDB(6,2)/EVBH3;
SET BTAC=@COEF(4)*CORRB(7,1)/MSDB(7,2)/EVBH1+@COEF(5)*CORRB(7,2)/
MSDB(7,2)/EVBH2+@COEF(6)*CORRB(7,3)/MSDB(7,2)/EVBH3;
SET BFCH=@COEF(4)*CORRB(8,1)/MSDB(8,2)/EVBH1+@COEF(5)*CORRB(8,2)/
MSDB(8,2)/EVBH2+@COEF(6)*CORRB(8,3)/MSDB(8,2)/EVBH3;
PRINT EVBH1 EVBH2 EVBH3;
PRINT BHOT BPIZ BLUN BTAC BFCH;

?CALCULATING STANDARD ERRORS OF THE ORIGINAL VARIABLES
SET STHOT=SQRT((CORRB(4,1)**2/EVBH1+CORRB(4,2)**2/EVBH2+CORRB(4,3)**2/
EVBH3)*SIG);
SET STPIZ=SQRT((CORRB(5,1)**2/EVBH1+CORRB(5,2)**2/EVBH2+CORRB(5,3)**2/
EVBH3)*SIG);
SET STLUN=SQRT((CORRB(6,1)**2/EVBH1+CORRB(5,2)**2/EVBH2+CORRB(5,3)**2/
EVBH3)*SIG);
SET STTAC=SQRT((CORRB(7,1)**2/EVBH1+CORRB(7,2)**2/EVBH2+CORRB(7,3)**2/
EVBH3)*SIG);
SET STFCH=SQRT((CORRB(8,1)**2/EVBH1+CORRB(8,2)**2/EVBH2+CORRB(8,3)**2/
EVBH3)*SIG);
PRINT STHOT STPIZ STLUN STTAC STFCH;

?SIMULATION ANALYSES
?PROBIT COEFFICIENTS
SET CC=0.2984;  SET CPC1=0.0556;  SET CPC2=0.0140;  SET CBH1=-0.0217;
SET CBH2=-0.0279;   SET CBH3=0.0275;  SET CATDOC=-0.0128;
SET CATREG=-0.0348;  SET CATCAL=0.0250;  SET CNTKNO=0.0477;
SET CNTPLN=-0.0544;   SET CNTLOK=-0.0013;  SET CDMMSZ=0.0496;
SET CNDMINC2=0.0366;  SET CNDMINC3=0.0267;  SET CDMHSZ=0.4388;
SET CDMAGE=0.0013;  SET CDMEDU=-0.0779;  SET CTDMFEM2=-0.0909;
SET CDTFEM2=-0.0532;  SET CPPBF=-0.0024;  SET CPPPL=0.0047;
SET CPPPK=0.0007;  SET CNDMREG2=0.1528;  SET CNDMREG3=0.0266;
SET CNDMREG4=0.0471;  SET CCK2=-0.2628;  SET CCK3=-0.2403;
SET CSQRTADV=0.2886;

?CONSUMPTION COEFFICIENTS
SET DC=2.5139; SET DPC1=0.1684; SET DPC2=0.0601;
SET DBH1=-0.0571; SET DBH2=-0.0634; SET DBH3=0.0901;
SET DATDOC=-0.0363; SET DATREG=-0.0981; SET DATCAL=0.0875;
SET DNTKNO=0.1388; SET DNTPLN=-0.1954; SET DNTLOK=-0.0008;
SET DDMMSZ=0.1606; SET DNDMINC2=0.1113; SET DNDMINC3=0.1402;
SET DDMHSZ=0.8721; SET DDMAGE=-0.0136; SET DDMEDU=-0.2696;
SET DTDMFEM2=-0.3216; SET DDTFEM2=-0.1453;
SET DPPBF=-0.0072; SET DPPPL=0.0134; SET DPPPK=0.0025;
SET DNDMREG2=0.5296; SET DNDMREG3=0.1115; SET DNDMREG4=0.2330;
SET DCK2=-0.8406; SET DCK3=-0.7804; SET DSQRTADV=0.8235;
SET DSIGMA=3.4236; SET DRHO=0.9993;

MFORM(TYPE=GEN, NROW=29, NCOL=1) CBETA;
SET CBETA(1)=CC; SET CBETA(2)=CPC1; SET CBETA(3)=CPC2;
SET CBETA(4)=CBH1; SET CBETA(5)=CBH2; SET CBETA(6)=CBH3;
SET CBETA(7)=CATDOC; SET CBETA(8)=CATREG; SET CBETA(9)=CATCAL;
SET CBETA(10)=CNTKNO; SET CBETA(11)=CNTPLN; SET CBETA(12)=CNTLOK;
SET CBETA(13)=CDMMSZ; SET CBETA(14)=CNDMINC2; CBETA(15)=CNDMINC3;
SET CBETA(16)=CDMHSZ; SET CBETA(17)=CDMAGE; SET CBETA(18)=CDMEDU;
SET CBETA(19)=CTDMFEM2; SET CBETA(20)=CDTFEM2; SET CBETA(21)=CPPBF;
SET CBETA(22)=CPPPL; SET CBETA(23)=CPPPK; SET CBETA(24)=CNDMREG2;
SET CBETA(25)=CNDMREG3; SET CBETA(26)=CNDMREG4; SET CBETA(27)=CCK2;
SET CBETA(28)=CCK3; SET CBETA(29)=CSQRTADV;
?29 ENTRIES

MFORM(TYPE=GEN, NROW=31, NCOL=1) DBETA;
SET DBETA(1)=DC; SET DBETA(2)=DPC1; SET DBETA(3)=DPC2;
SET DBETA(4)=DBH1; SET DBETA(5)=DBH2; SET DBETA(6)=DBH3;
SET DBETA(7)=DATDOC; SET DBETA(8)=DATREG; SET DBETA(9)=DATCAL;
SET DBETA(10)=DNTKNO; SET DBETA(11)=DNTPLN; SET DBETA(12)=DNTLOK;
SET DBETA(13)=DDMMSZ; SET DBETA(14)=DNDMINC2; DBETA(15)=DNDMINC3;
SET DBETA(16)=DDMHSZ; SET DBETA(17)=DDMAGE; SET DBETA(18)=DDMEDU;
SET DBETA(19)=DTDMFEM2; SET DBETA(20)=DDTFEM2; SET DBETA(21)=DPPBF;
SET DBETA(22)=DPPPL; SET DBETA(23)=DPPPK; SET DBETA(24)=DNDMREG2;
SET DBETA(25)=DNDMREG3; SET DBETA(26)=DNDMREG4; SET DBETA(27)=DCK2;
SET DBETA(28)=DCK3; SET DBETA(29)=DSQRTADV; SET DBETA(30)=DSIGMA;
SET DBETA(31)=DRHO;
ID=1;

SELECT CK3=1;  ?WHICH INDICATES SIMULATION OVER 1991-1993
MSD(NOPRINT) ID PC1 PC2 BH1 BH2 BH3 ATDOC ATREG ATCAL NTKNO NTPLN
NTLOK
DMMSZ NDMINC2 NDMINC3 DMHSZ DMAGE DMEDU TDMFEM2 DTFEM2
PPBF PPPL PPPK NDMREG2 NDMREG3 NDMREG4 CK2 CK3 SQRTADV;
SET XD=0; SET XC=0;
SET RG2=0;
SET RG3=0;
SET RG4=1;
SET CKK2=0;
SET CKK3=1;
SET POPP=258;

DO I=4 TO 23; ?CREATING XD AT THE MEANS EXCEPT REG1 CK3 AND
?ADVERTISING
?EXCLUDING THE HEALTH PC VARIABLES
SET XD=XD+DBETA(I)*@MEAN(I);
SET XC=XC+CBETA(I)*@MEAN(I);
ENDDO;
```

```
SET BFCHK=6.0;

SET XXD=DBETA(1)+XD+DBETA(24)*RG2+DBETA(25)*RG3+DBETA(26)*RG4+
DBETA(27)*CKK2+DBETA(28)*CKK3+DBETA(29)*SQRT(BFCHK*10/POPP);

SET
XXC=CBETA(1)+XC+CBETA(24)*RG2+CBETA(25)*RG3+CBETA(26)*RG4+CBETA(27)*
CKK2+CBETA(28)*CKK3+CBETA(29)*SQRT(BFCHK*10/POPP);
PRINT XXC XXD;

MFORM(TYPE=GEN, NROW=40, NCOL=10) health=0;
SET RR=0;
?PRINCIPAL COMPONENT RESULTS
SET EVPC1=3.1880847;
SET EVPC2=0.44330945;
SET L1NTFAT=0.89656;
SET L2NTFAT=0.27247;
SET L1NTCHL=0.87262;
SET L2NTCHL=0.38875;
SET L1NTADD=0.91568;
SET L2NTADD=-0.26167;
SET L1NTPRE=0.88562;
SET L2NTPRE=-0.38732;
MSD(NOPRINT) NTFAT NTCHL NTADD NTPRE;
SET HADD=3;
SET HPRE=3;

PRINT @MEAN;

DO H=1 TO 6 BY 1;
SET HFAT=H;
SET HCHL=H;

SET PPC1=
L1NTFAT*((HFAT-@MEAN(1))/@STDDEV(1))*(1/EVPC1)+
L1NTCHL*((HCHL-@MEAN(2))/@STDDEV(2))*(1/EVPC1)+
L1NTADD*((HADD-@MEAN(3))/@STDDEV(3))*(1/EVPC1)+
L1NTPRE*((HPRE-@MEAN(4))/@STDDEV(4))*(1/EVPC1);
PRINT PPC1;
SET PPC2=
L2NTFAT*((HFAT-@MEAN(1))/@STDDEV(1))*(1/EVPC2)+
L2NTCHL*((HCHL-@MEAN(2))/@STDDEV(2))*(1/EVPC2)+
L2NTADD*((HADD-@MEAN(3))/@STDDEV(3))*(1/EVPC2)+
L2NTPRE*((HPRE-@MEAN(4))/@STDDEV(4))*(1/EVPC2);
PRINT PPC2;

SET XXXD=XXD+DBETA(2)*PPC1+ DBETA(3)*PPC2;
SET XXXC=XXC+CBETA(2)*PPC1+ CBETA(3)*PPC2;
PRINT XXXC;
?SEE GREENE PAGE 744
SET LAMBDA=NORM(XXXC)/(CNORM(XXXC));
SET XXXCC=CNORM(XXXC);
SET Y1=XXXCC;
SET Y2=XXXD+DBETA(30)*DBETA(31)*LAMBDA;

SET RR=RR+1;
SET J=1; SET IJ=(J-1)*40+RR;
SET health(IJ)=HFAT;
SET J=2; SET IJ=(J-1)*40+RR;
SET health(IJ)=HCHL;
SET J=3; SET IJ=(J-1)*40+RR;
SET health(IJ)=Y1;
SET J=4; SET IJ=(J-1)*40+RR;
SET health(IJ)=Y2;
SET J=5; SET IJ=(J-1)*40+RR;
SET health(IJ)=RG2;
SET J=6; SET IJ=(J-1)*40+RR;
SET health(IJ)=RG3;
SET J=7; SET IJ=(J-1)*40+RR;
SET health(IJ)=RG4;
ENDDO;
WRITE(FORMAT=LOTUS, FILE='C:\WMOON\simulatn\health#1.WQ1') health;
PRINT health;
END;

?SIMULATION OVER BEEF PRICE AND CHECKOFF EXPENDITURES
SET XD=0; SET XC=0;
SET RG2=0;
SET RG3=0;
SET RG4=1;
SET CKK2=0;
SET CKK3=1;
SET POPP=258;
SET MPPPL=@MEAN(22);
SET MPPPK=@MEAN(23);

DO I=1 TO 20; ?CREATING XD AT THE MEANS EXCEPT REG1 CK3 BEEF PRICE AND
?ADVERTISING

SET XD=XD+DBETA(I)*@MEAN(I);
SET XC=XC+CBETA(I)*@MEAN(I);
ENDDO;

?HOLDING PORK AND POULTRY PRICES AT THEIR MEANS
SET XXD=XD+DBETA(22)*MPPPL+DBETA(23)*MPPPK+
DBETA(24)*RG2+DBETA(25)*RG3+DBETA(26)*RG4+
DBETA(27)*CKK2+DBETA(28)*CKK3;

SET XXC=XC+CBETA(22)*MPPPL+CBETA(23)*MPPPK+
CBETA(24)*RG2+CBETA(25)*RG3+CBETA(26)*RG4+CBETA(27)*CKK2
+CBETA(28)*CKK3;

MFORM(TYPE=GEN, NROW=210, NCOL=40) SADV=0;
SET RR=0;
DO JJ=1 TO 30;
SET BFCHK=(JJ-1)*.5;
SET CCADV=CBETA(29)*SQRT(BFCHK*10/POPP);
SET DDADV=DBETA(29)*SQRT(BFCHK*10/POPP);

DO II=1 TO 121;
SET PRBF=200+(II-1);
SET XXXD=XXD+DDADV+DBETA(21)*PRBF;
SET XXXC=XXC+CCADV+CBETA(21)*PRBF;

?SEE GREENE PAGE 744
SET LAMBDA=NORM(XXXC)/(CNORM(XXXC));
SET XXXCC=CNORM(XXXC);
SET Y1=XXXCC;
SET Y2=XXXD+DBETA(30)*DBETA(31)*LAMBDA;

SET IJ=1;
SET SADV(IJ)=0;
SET IJ=(JJ)*210+1;
SET SADV(IJ)=BFCHK;
SET IJ=II+1;
SET SADV(IJ)=PRBF;
SET J=JJ;
SET I=II+1;
SET IJ=(J)*210+I;
SET SADV(IJ)=Y2;
ENDDO;
ENDDO;
WRITE(FORMAT=LOTUS, FILE='C:\WMOON\simulatn\SIML#22.WQ1') SADV;
PRINT SADV;

?SIMULATION OVER SELECTED DEMOGRAPHIC VARIABLES:MARKET SIZE
DO I=1 TO 12;

SET XD=XD+DBETA(I)*@MEAN(I);
SET XC=XC+CBETA(I)*@MEAN(I);

DO I=14 TO 23; ?EXCLUDING DMMSZ
SET XXD=XD+DBETA(I)*@MEAN(I);
SET XXC=XC+CBETA(I)*@MEAN(I);

ENDDO;
ENDDO;

SET XXXD=XXD+DBETA(24)*RG2+DBETA(25)*RG3+DBETA(26)*RG4+
DBETA(27)*CKK2+DBETA(28)*CKK3+DBETA(29)*@MEAN(29);

SET
XXXC=CBETA(1)+XC+CBETA(24)*RG2+CBETA(25)*RG3+CBETA(26)*RG4+CBETA(27)
*CKK2
+CBETA(28)*CKK3+CBETA(29)*@MEAN(29);
PRINT XXXC XXXD;

DO M=1 TO 5 BY 1;
SET XXXXD=XXXD+DBETA(13)*M;
SET XXXXC=XXXC+CBETA(13)*M;
set xxxcc=cnorm(xxxxc);
set lambda=norm(xxxxc)/(cnorm(xxxxc));
set xxxxdd=xxxxd+dbeta(30)*dbeta(31)*lambda;
PRINT M xxxxd XXXXdD XXXcC;
ENDDO;
END;
```

TSP Databank of Contents

```
 Current sample:  1 to 17109

 Contents of Databank   C:\WMOON\NPD\BFN93#0.TLB

 Class     Name      Description
 -----     ----      -----------

 SERIES    ID        17109 obs. from  1-17109, no frequency
           YR        17109 obs. from  1-17109, no frequency
           WAVE      17109 obs. from  1-17109, no frequency
           DMHSZ     17109 obs. from  1-17109, no frequency
           DMMSZ     17109 obs. from  1-17109, no frequency
           DMCHL     17109 obs. from  1-17109, no frequency
           DMFEM     17109 obs. from  1-17109, no frequency
           DMAGE     17109 obs. from  1-17109, no frequency
           DMEDU     17109 obs. from  1-17109, no frequency
           DMREG     17109 obs. from  1-17109, no frequency
           DMINC     17109 obs. from  1-17109, no frequency

 THIS DATABANK HAS        1429 WASTED BLOCKS (       731896 BYTES)
 WHICH COULD BE REMOVED WITH THE  DBCOMP  COMMAND.


 Contents of Databank   C:\WMOON\NPD\BFN93#1.TLB

 Class     Name      Description
 -----     ----      -----------

 SERIES    DMPCI     17109 obs. from  1-17109, no frequency
           DTCHL     17109 obs. from  1-17109, no frequency
           DTMAL     17109 obs. from  1-17109, no frequency
           DTFEM     17109 obs. from  1-17109, no frequency
           CNBEF     17109 obs. from  1-17109, no frequency
           CNPOR     17109 obs. from  1-17109, no frequency
           CNHAM     17109 obs. from  1-17109, no frequency
           CNBAC     17109 obs. from  1-17109, no frequency
           CNOTH     17109 obs. from  1-17109, no frequency
           CNCHK     17109 obs. from  1-17109, no frequency
           CNTUR     17109 obs. from  1-17109, no frequency
           CNPOL     17109 obs. from  1-17109, no frequency
           CNFSH     17109 obs. from  1-17109, no frequency
```

```
                  CNCAN    17109 obs. from  1-17109, no frequency
                  CNPRO    17109 obs. from  1-17109, no frequency
                  ATSNK    17109 obs. from  1-17109, no frequency
                  ATFRY    17109 obs. from  1-17109, no frequency
                  ATFOR    17109 obs. from  1-17109, no frequency
                  ATBAK    17109 obs. from  1-17109, no frequency
                  ATLAB    17109 obs. from  1-17109, no frequency

        THIS DATABANK HAS 2599 WASTED BLOCKS (1330720 BYTES)
        WHICH COULD BE REMOVED WITH THE  DBCOMP  COMMAND.


        Contents of Databank  C:\WMOON\NPD\BFN93#2.TLB

        Class    Name     Description
        -----    ----     -----------

        SERIES   ATDOC    17109 obs. from  1-17109, no frequency
                 ATREG    17109 obs. from  1-17109, no frequency
                 ATWGT    17109 obs. from  1-17109, no frequency
                 ATSWM    17109 obs. from  1-17109, no frequency
                 ATCAL    17109 obs. from  1-17109, no frequency
                 ATLBS    17109 obs. from  1-17109, no frequency
                 FDHOT    17109 obs. from  1-17109, no frequency
                 FDCER    17109 obs. from  1-17109, no frequency
                 FDBER    17109 obs. from  1-17109, no frequency
                 FDWIN    17109 obs. from  1-17109, no frequency
                 FDMLK    17109 obs. from  1-17109, no frequency
                 FDBRD    17109 obs. from  1-17109, no frequency
                 FDRIC    17109 obs. from  1-17109, no frequency
                 FDSKM    17109 obs. from  1-17109, no frequency
                 FDMAR    17109 obs. from  1-17109, no frequency
                 FDCOF    17109 obs. from  1-17109, no frequency
                 FDSWT    17109 obs. from  1-17109, no frequency
                 FDTUR    17109 obs. from  1-17109, no frequency
                 FDPIZ    17109 obs. from  1-17109, no frequency
                 FDLUN    17109 obs. from  1-17109, no frequency
                 FDFFR    17109 obs. from  1-17109, no frequency

        THIS DATABANK HAS 2729 WASTED BLOCKS (1397256 BYTES)
        WHICH COULD BE REMOVED WITH THE  DBCOMP  COMMAND.


        Contents of Databank  C:\WMOON\NPD\BFN93#3.TLB

        Class    Name     Description
        -----    ----     -----------

        SERIES   FDTAC    17109 obs. from  1-17109, no frequency
                 FDFCH    17109 obs. from  1-17109, no frequency
                 NTKNO    17109 obs. from  1-17109, no frequency
                 NTPLN    17109 obs. from  1-17109, no frequency
                 NTCHL    17109 obs. from  1-17109, no frequency
        NTVIT    17109 obs. from  1-17109, no frequency
        NTING    17109 obs. from  1-17109, no frequency
        NTFRU    17109 obs. from  1-17109, no frequency
        NTSUG    17109 obs. from  1-17109, no frequency
        NTADD    17109 obs. from  1-17109, no frequency
        NTFAT    17109 obs. from  1-17109, no frequency
        NTSAL    17109 obs. from  1-17109, no frequency
        NTPRE    17109 obs. from  1-17109, no frequency
        NTCAF    17109 obs. from  1-17109, no frequency
        NTFRS    17109 obs. from  1-17109, no frequency
        NTCAN    17109 obs. from  1-17109, no frequency
        NTLOK    17109 obs. from  1-17109, no frequency
        NTBRN    17109 obs. from  1-17109, no frequency
        NTTAS    17109 obs. from  1-17109, no frequency

THIS DATABANK HAS 2469 WASTED BLOCKS (1264184 BYTES)
WHICH COULD BE REMOVED WITH THE  DBCOMP  COMMAND.


Contents of Databank  C:\WMOON\NPD\BFN93#4.TLB

Class    Name     Description
-----    ----     -----------

SERIES   PRCOV    2958 obs. from  14152-17109, no frequency
         PRFRY    2958 obs. from  14152-17109, no frequency
         PRSUG    2958 obs. from  14152-17109, no frequency
         PRCHO    2958 obs. from  14152-17109, no frequency
         PRFAT    2958 obs. from  14152-17109, no frequency
         PRSAL    2958 obs. from  14152-17109, no frequency
         PRSER    2958 obs. from  14152-17109, no frequency
         PRCAF    2958 obs. from  14152-17109, no frequency


Contents of Databank  C:\WMOON\NPD\BFWAVE93.TLB

Class    Name     Description
-----    ----     -----------

SERIES   WAVE     17109 obs. from  1-17109, no frequency
         YEAR     17109 obs. from  1-17109, no frequency
         QTR      17109 obs. from  1-17109, no frequency

SCALAR   I        constant 40.00000
         YY       constant 1993.00000
         QQ       constant 4.00000

SERIES   TM       17109 obs. from  1-17109, no frequency

THIS DATABANK HAS 389 WASTED BLOCKS (199608 BYTES)
WHICH COULD BE REMOVED WITH THE  DBCOMP  COMMAND.
```

```
Contents of Databank  C:\WMOON\NPD\NPDPRC.TLB

Class    Name      Description
-----    ----      -----------

SERIES   YR        38 obs. from  1-38, no frequency
         QT        38 obs. from  1-38, no frequency
         RPBF      38 obs. from  1-38, no frequency
         RPPK      38 obs. from  1-38, no frequency
         RPPL      38 obs. from  1-38, no frequency
         RPTK      38 obs. from  1-38, no frequency
         TOTADV    38 obs. from  1-38, no frequency
         POPUL     38 obs. from  1-38, no frequency
         CPI       38 obs. from  1-38, no frequency

MATRIX   PBF       38x1 general
         PPK       38x1 general
         PPL       38x1 general
         PTK       38x1 general
         ADV       38x1 general
         POP       38x1 general
         INX       38x1 general

SERIES   WAVE      17109 obs. from  1-17109, no frequency
         YEAR      17109 obs. from  1-17109, no frequency
         QTR       17109 obs. from  1-17109, no frequency

SCALAR   YRR       constant 1993.00000

SERIES   PPBF      17109 obs. from  1-17109, no frequency
         PPPK      17109 obs. from  1-17109, no frequency
         PPPL      17109 obs. from  1-17109, no frequency
         PPTK      17109 obs. from  1-17109, no frequency
         TADV      17109 obs. from  1-17109, no frequency
         PPOP      17109 obs. from  1-17109, no frequency
         IINX      17109 obs. from  1-17109, no frequency

SCALAR   QRR       constant 4.00000
         JJ        constant 40.00000
```

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentaion and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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